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THE PENNSYLVANIA RAILROAD LOW GRADE FREIGHT LINE FROM HARRISBURG TO ATGLEN, PA.

One of the most notable pieces of railway grading which has been undertaken anywhere in the United States east of the Rocky Mountains in recent years is now approaching completion on the new low grade freight line that the Pennsylvania Railroad is building between Harrisburg and Philadelphia, Pa. The very heavy work to be noted here is, however, confined to a small portion of this line which lies between Columbia in Lancaster County and Atglen in Chester County, 35 miles; in fact, the great bulk of the yardage is comprised in the 10-mile stretch of this 35-mile section between station 1530, south of Washington Borough, and station 1000, east of Martic Forge. In this stretch the cutting will amount to nearly 4,000,000 cu. yds., or about 400,000 cu. yds. per mile. A condensed profile of this section of heaviest work is given in Figs. 1 and 2.

THE PURPOSE OF THE WORK.

Before taking up the study of these profiles, however, a few words of explanation are necessary to establish the position of this new work in the general scheme of line improvement now being carried out by the Pennsylvania Railroad between Pittsburg and New York. For a number of years this great trunk line has been suffering from increasing congestion of its freight traffic, because, first, of inadequate yard and line facilities in the large cities passed through; second, of inadequate trackage between these gathering points, and, third, of excessive grades, necessitating the splitting of trains or the use of pusher engines at frequent points. To overcome these obstacles the engineers of the company settled upon a comprehensive plan of improvement involving, first, the enlargement of yard and station facilities in the larger cities, second, the elimination of curves and reduction of grades on the existing lines, and, third, the construction of new lines at various points to get alternative low grade lines for freight traffic.

A description in detail of the numerous works involved in the above described plan is wholly impossible, but the result may be summed up by the statement that at a cost of something over a hundred million dollars the Pennsylvania R. R. will, with its planned improvements completed, be able to haul 85-car trains 445 miles from Pittsburg to tidewater at New York, with the help of pusher engines at only two points, namely, in getting out of Pittsburg and at the divide of the Allegheny Mountains.

Coming now to the particular improvement that is the subject of this article, it is to be noted that 80 and 100-car trains from the Allegheny Mountains come unbroken to Harrisburg or by branch to Columbia, but, owing to the heavy grades from either of these points on to Philadelphia, they have there to be broken up into three trains. The purpose of the new line is, of course, to obviate this reduction of train length; it also does away with the necessity of passing through trains through Harrisburg, and gives an additional double track line from Harrisburg east to a point on the main line near Atglen. Briefly described, the new line begins at the new Eola yards opposite Harrisburg, and follows down the west bank of the Susquehanna River to Shock Mills, where it crosses to the east bank and continues down the old Pennsylvania Canal to Columbia. From Columbia the route follows the east bank of the Susquehanna to Shenk's Ferry and then turns east across country through Martic Forge, New Providence, Quarryville and Green Tree to Atglen, where connection is made with the main line. The total length of the new line from Eola yards to Atglen is 72 miles, and it will be double track throughout, with no grade exceeding 15 ft. per mile, and no curve sharper than 2°.

VIEW SHOWING EXPLOSION OF 175-TON BLAST, PENNSYLVANIA R. R. CONSTRUCTION ALONG THE SUSQUEHANNA RIVER.

CHARACTER OF THE WORK.

The construction of the new low grade freight line involves very little work that is out of the ordinary until the line reaches a point about 5½ miles south of Columbia. Here the hills between which the Susquehanna takes its course come close to the water's edge in a series of bluffs and headlands separated by ravines. The grade line, which has followed the low-lying shore previously, begins at a point a little south of Columbia to rise on a fill until it strikes the first of the bluffs at about station 1550 (Columbia Depot is at about station 1850). From this point all the way to Shenk's Ferry the work is a series of side hill cuts through the bluffs and of fills across the intervening ravines. The heavy work continues as the line swings eastward from Shenk's Ferry across country, but here, of course, the cuts are through cuts. After Martic Forge is passed the yardage decreases, but yet continues to be considerable clear to Atglen.

Referring to the profiles, Fig. 1 shows the work along the river bank to Shenk's Ferry. In the stretch of work shown here the total yardage of cut (station 1550 to 1190) is 2,863,963 cu. yds. This yardage is practically all rock, and is made up of a shelf taken out of the bluff face. The depth of cut, as shown by the profile, runs frequently to from 60 to 100 ft., and in places approaches 200 ft. From Shenk's Ferry (station 1190) to Martic Forge (station 1000) the total yardage is 1,064,900 cu. yds. of cut and 856,000 cu. yds. of fill. The average depth of cuts (Fig. 2) is much less, but from the fact that they are through cuts instead of side cuts the yardage runs very high. These details are all made quite clear by the drawings.

All things considered, the portion of the grading of greatest difficulty was that lying along the river bluffs from Shenk's Ferry north about seven miles to station 1550. The bluffs along this stretch come to the river in a series of headlands that drop steeply to the water's edge from elevations of from 100 to 500 ft. A fairly clear idea of the

topography is given by the view Fig. 3, and incidentally by several of the other views reproduced here. When it is recalled that the roadbed of the new line is midway of the height of these cliffs, some idea of the inaccessibility of the work is obtained. To realize this fully, however, one has to visit the ground. In the following paragraphs the description relates wholly to the heavy yardage in respect to the cuts that the task before the contractors was essentially one of wasting the rock in the quickest and cheapest way. This was, of course, to cast it down the cliff face into the river, and, so far as possible, it was attempted to do this by blasting. By far the greatest portion of the yardage removed was taken out by individual great blasts, which cast 700 ft. long, with an average depth of abo[illegible] ft. and an average width of about 100 ft. Th[illegible] op of this prism was from 135 to 140 ft. below [illegible] top of the cliff, and the drills had to be let d[illegible] this distance by block and tackle from the cli[illegible] bove. For the deep holes well drills were used[illegible] d to lower these heavy machines down such [illegible] oads as could be rough hewn in the cliff face w[illegible] itself

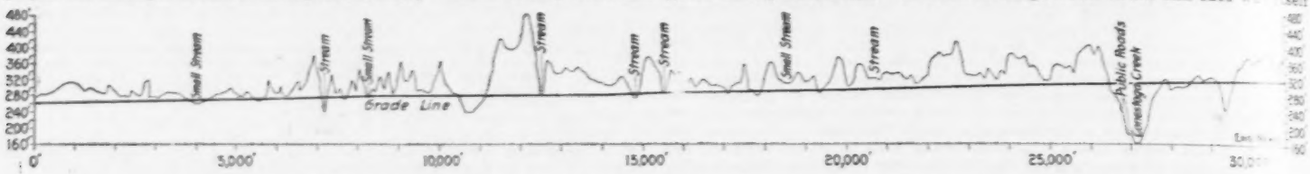


FIG. 1. PROFILE OF PORTION OF LOW GRADE FREIGHT LINE OF PENNSYLVANIA R. R. ALONG SUSQUEHANNA RIVER BETWEEN COLUMBIA AND SHENK'S FERRY.

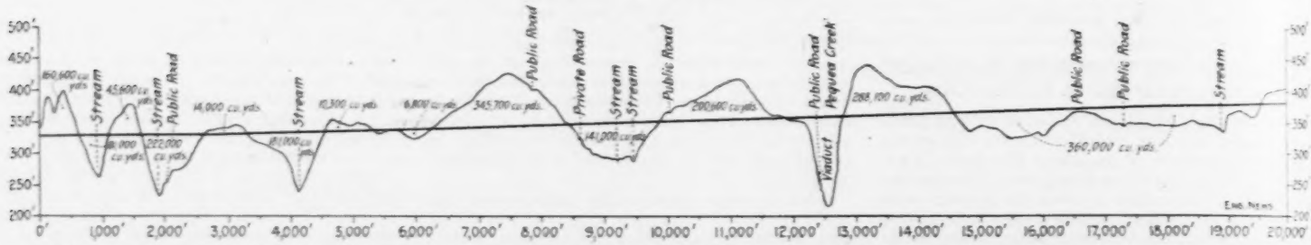


FIG. 2. PROFILE OF PORTION OF LOW GRADE FREIGHT LINE OF PENNSYLVANIA R. R. FROM SHENK'S FERRY TOWARD ATGLEN, PA.

work along the Susquehanna River. This section from Columbia to Shenk's Ferry has been constructed by H. S. Kerbaugh, Ltd., of Philadelphia, Pa., as contractors.

METHODS OF WORK.

The general plan of work decided upon was the obvious one of breaking out a triangular prism from the cliff face by heavy blasts and clearing off a shelf by steam shovels casting the broken rock over the edge of the bank into the river or loading it into cars for transportation to the fills. The fills, however, were so small in the rock down the cliffs and clear of the roadway. A single illustration will indicate the efficiency of the method and explain well enough the general mode of procedure in other places all along the line.

STIGERWALTS BLAST.—The special blast chosen for illustration is known as the Stigerwalts blast, and consisted in removing a nose or headland of rock lying about one-half mile west of Safe Harbor. A view of this nose at the beginning of work is shown by Fig. 4. The prism it was desired to move was between 600 ft. and a task of magnitude. Triple blocks and steel cables were required for the task. The view Fig. 5 shows a group of well drills in place.

The holes were drilled in rows parallel to the length of the cut. There were 80 well-drill holes, averaging 115 ft. in depth, and 123 rock-drill holes, none less than 30 ft. deep. The drilling commenced on July 1 and was finished on Aug. 1; the springing of the holes was completed on Saturday, Aug. 19. The holes were allowed until Monday to cool, when loading was begun at 7 a. m. and completed on Tuesday at 5 a. m. Dur-

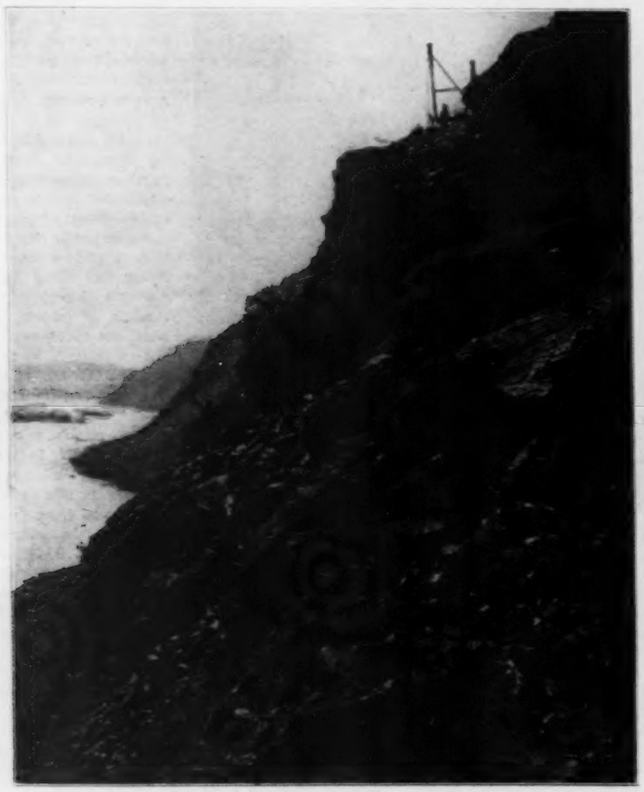


FIG. 3. VIEW ALONG SUSQUEHANNA RIVER, SHOWING ROCKY BLUFFS ALONG WHICH PENNSYLVANIA R. R. LOW GRADE FREIGHT LINE IS CONSTRUCTED.

FIG. 4. VIEW OF CLIFF FROM WHICH 240,000-CU. YD. CUT WAS TAKEN BY A SINGLE BLAST (STIGERWALTS' BLAST).

ing this time there were placed 2,262 boxes of dynamite or 56.7 tons, 278 boxes of Judson, or 7 tons, and 12,805 kegs of black powder, 161.3 tons, or altogether, 225 tons of explosive.

It will be understood that such rapid loading of so many holes and the handling of so large an amount of explosives was made possible only by the most careful and well-considered plans for the rapid supplying of the men at each hole with explosive as fast as they could use it and in shape

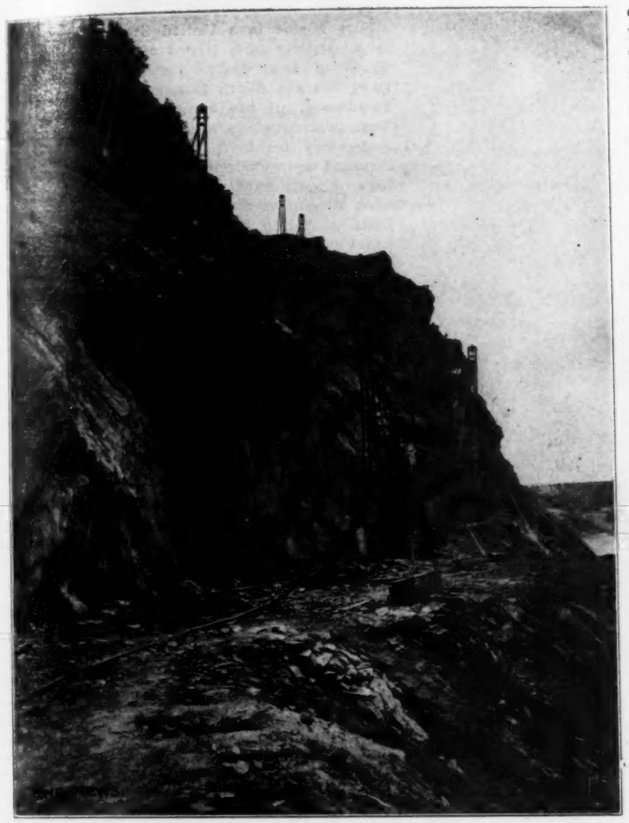


FIG. 5. VIEW SHOWING WELL DRILLS AT WORK, STIGERWALTS' BLAST.

to be placed in the holes. Altogether, 200 men and ten four-mule teams were employed continuously during the 22 hours, stopping only to eat, and for that in relays, so that the work did not stop at all. The teams brought the explosive to the top of the bluff, whence it was delivered to the holes either by hand or by chuting. The path down the bluff being too steep for men carrying boxes of dynamite to descend safely, the men were made to stand in line and to pass the boxes from man to man from the top of the hill down to the holes. By this arrangement the dynamite was handled at the rate of 250 boxes in 20 minutes. Fig. 6 is a view showing the dynamite gang at work. The handling of the black powder was a simpler matter. It was emptied from the kegs into a wooden hopper 8 ft. long, 4 ft. wide and 3 ft. high, set in the crest of the bluff. From this hopper two 3-in. pipes extended down the cliff to a platform where, by means of improvised gates or valves, the powder flowing down the pipes was discharged into 50-lb. boxes, which the men carried to the holes. The view Fig. 7 shows the lower end of the pipes and the process of loading and taking away the boxes.

Besides the explosives mentioned above, there were used in this blast 1,600 submarine exploders in lengths of from 40 to 100 ft. These exploders were made by the Star Electric Fuse Works, of Wilkes-Barre, Pa., and were supplied to the contractor by the G. R. McAbee Powder & Oil Co., Pittsburg, Pa., which also supplied all the explosives used. Summarized briefly, eight well drills and sixteen rock drills were employed continuously day and night for 30 days in drilling the holes for this blast, and 200 men and ten four-mule teams were employed continuously 22 days in handling the explosives necessary for the springing and loading of the holes. The following figures of cost are given by the contractor:

Total cost of explosives used, inc. exploders..	$29,927
Total labor cost for drilling and handling of the explosives	45,391
Grand Total	$75,318

According to rough estimates made by the engineers, 240,000 cu. yds. of rock were loosened, of which probably 175,000 cu. yds. were thrown clear of the work. The blast, whose loading was completed at 5 a. m. on Aug. 22, was fired at 5 p. m. on the same day. Fig. 8 is a view of the explosion.

DIFFICULTIES OF CONSTRUCTION.—The blast just described illustrates fairly well the method of excavation all along the line. Of course the great bulk of the blasting was not done in such enormous units, but there were a number of other large blasts, one of which is illustrated by Fig. 9. Here 175 tons of explosives, consisting of 300,000 lbs. of black powder, 15,000 lbs. of Judson, and 35,000 lbs. of dynamite, were placed in 65 six-in. holes, 85 ft. deep.

Turning to generalities, the mode of procedure in all of these side hill rock cuts was to drill rows of holes parallel to the cut and to fire these holes so as to loosen a triangular prism of rock, which, when cleared away, would leave a shelf on the cliff face for the roadbed. The drilling was done by rock drills and by well-drilling machines, the latter being used for the deep holes. In the section of work from Shenk's Ferry to Columbia, 48 well drills and 150 Ingersoll-Sergeant rock drills were used, all operated by compressed air from a central compressor plant, as will be described later.

The rows of vertical holes, except where the cut to be made was shallow, were put down with well drills; Star Traction No. 1 machines, made by the Star Drilling Machine Co., of Akron, Ohio, were employed. These gave a 5½-in. hole inside the casing, and some of the holes drilled were over 135 ft. deep. The advantage of these large holes lay chiefly in the room they offered for "springing" charges. The rock drills were used mostly for putting in the horizontal or "snake" holes. These holes ran to a maximum depth of 35 ft., giving a top diameter of 4½ ins. and a bottom diameter of 1⅝ ins. For breaking up large rocks left in the excavation by the main blast, use was made of "Little Jap" hammer drills. Generally a hole 6 ins. deep charged with a single stick of dynamite was enough to break up any ordinary rock.

Despite the fact that the blasting was so planned as to throw the great bulk of the rock clear of the excavation, there remained much loose rock to be cleared away. This clearing was done by steam shovels, which either cast the spoil over the lower cliff edge or else loaded it into cars hauled by "dinky" engines to be used in the fills. Altogether some 15 steam shovels were used on this section of the work. These were operated by steam, principally for the reason that the air pressure supplied from the central power plant was inadequate for steam shovel demands.

Perhaps the greatest difficulty encountered in the work consisted in getting the steam shovels, well drills and other plants onto the work. The new line, it is to be borne in mind, occupies a shelf midway up the steep cliffs that border the river. Along the foot of these cliffs, following the river's edge, were the tracks of the Columbia & Port Deposit R. R. All plant had to be brought in either by this railway and hoisted up the cliffs, or else taken inland by highway, then brought by construction roads to the cliff crest and finally lowered down the cliff face to position. A glance at the cliff faces shown in Figs. 3 and 4, which are characteristic examples, will make clear the magnitude of the task. Zigzag roads had to be cut in the steep rock, up or down which the shovels and well drills were moved by block and tackle. These same roads served later for taking in material and supplies from the inland side; the railway tracks at the foot of the cliff had to be abandoned as soon as work was begun, and the roadbed is now covered with the spoil cast over the cliffs in excavating for the new line. As indicating the difficulty of moving the plant into position, it may be noted that the money expended in getting a steam shovel onto the work often equalled the purchase price of the shovel.

CENTRAL POWER PLANT.

The well-drilling machines and the rock drills are all operated by compressed air. To supply the air needed for this large number of drills working day and night, the contractors installed one of the largest contractor's compressor plants ever built in this country. This plant was located at Safe Harbor, the machinery being placed in a large brick building formerly used for manufacturing purposes. Briefly described, it consists of 24 boilers of 100 HP. each, supplying steam to eight air-compressors, and of an air main running the full length of the work, or about 9 miles long.

The boilers, which are 24 in number, are of the horizontal tubular locomotive type, each with a capacity of 100 HP., giving 2,400 as the total available boiler horse-power. Coal is delivered to the furnaces by hand cars running on tracks, and the furnaces are stoked by hand, the fuel consumption per day being about 40 tons of slack coal. The steam pressure is 100 lbs. gage. Three 10 × 7 × 10-in. duplex steam pumps are used in supplying the water, gotten from a dam two miles

Fig. 6. View Showing Men "Passing" Dynamite for Stigerwalts' Blast.

distant, to the boiler for feed and to the compressors for cooling the jacket and serving the intercooler; the third pump is used for emergency. The connections from the pumps to the boilers and compressors are such that interchangeability is possible. A 2,000-HP. vertical

feed-water heater is employed in connection with the boiler feed.

The compressors are eight in number, each being an Ingersoll-Sergeant Class A straight-line, single-stage machine, with a stroke of 30 ins., and with 24-in. and 24¼-in. steam and air cylinder diameters, respectively. The displacement capacity of each, when operated at the rated speed of 80 R. P. M., is 1,223 cu. ft. of free air per minute, giving as the *free* air capacity of the plant 9,784 cu. ft., at a terminal pressure of 95 lbs. per sq. in. The inlet valves are of the piston type, while the discharge valves are direct-lift.

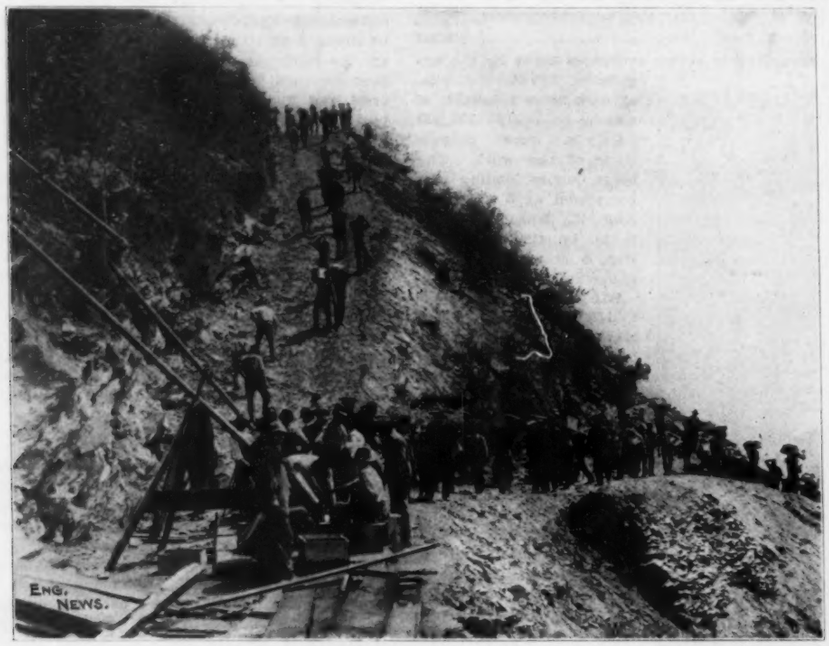


FIG. 7. VIEW SHOWING PIPES FOR CHUTING BLACK POWDER DOWN THE CLIFF, STIGERWALTS' BLAST.

Governing is effected by means of the Sergeant "air-ball" combined speed and pressure regulator. The air cylinders are completely water-jacketed. A separate foundation is provided for each machine, and the pipe connections and valves supplied are such that any compressor may be cut out if necessary. Four vertical receivers, 14 ft. high by 5 ft. diameter, are included, to remove any fluctuations in pressure due to the varying demand for compressed air. The precipitated moisture is removed at frequent intervals through valves provided for that purpose.

Leading from the receivers, to which the compressors are connected by a 6-in. pipe header, is a 12-in. main. This main divides outside of the power-house, one branch, an 8-in. pipe, running along the eastern bank of the creek for 3,250 ft., and the other branch, a 12-in. pipe, running about 3,650 ft. to supply the western section. The latter line crosses Conestoga Creek near the power-house on a cable suspension bridge. The pipe line is laid on the earth's surface following the contour of the country, and screw joints are everywhere employed, with perhaps the exception of every 500 ft., where a flanged joint is used to facilitate installation. Every 400 ft. a 3-in. "tee" is introduced, from which a pipe runs down the hill to the work below. Swing joints are provided to care for contraction and expansion, so that no leaks may occur to mar the efficiency of the system, and drain cocks are provided at low places so that the entrained water of precipitation may be removed. Of course, as the distance from the central station becomes greater and greater, the diameter of the pipe line is reduced; 3-in. mains supply the machines. Numerous branches and sub-branches are included in the pipe line, in which there are about 40,000 ft. About three-fourths of the total line, or 28,650 ft., is the largest direct transmission.

The compressors, besides furnishing air to the drills, also supply it for pumps, blacksmith's forges, etc., along the line.

ENGINEERS.

The low grade freight line construction, like all the other improvement work mentioned above, is being carried out under the direction of Mr. William H. Brown, Chief Engineer, Pennsylvania R. R., Philadelphia, Pa. Mr. J. F. Murray, Lancaster, Pa., is Assistant Engineer in direct charge of the work described.

ROADMAKING IN IRELAND was the subject of an address by Mr. P. C. Cowan, M. Inst. C. E., of the Local Government Board of Ireland, delivered on Nov. 17 before the Engineering Students' Society of Dublin University. Mr. Cowan urged the more extensive use of steam road rollers and also the adoption by county authorities of the provisions of an act authorizing them to designate main highways as county roads and improve them. Money for steam road rolling can now be raised in Ireland on five-year loans. For city streets Mr. Cowan favored an asphaltic pavement containing enough grit or sharp sand to give a good foothold for horses.

THE CONSTRUCTION OF A REINFORCED CONCRETE RESERVOIR AT FORT MEADE, SOUTH DAKOTA.

By Samuel H. Lea,* M. Am. Soc. C. E.

INTRODUCTORY.

Before giving the details of the reservoir and of its construction a brief description will be given of the locality, the local conditions of water supply requiring its construction, and of the new pipe line connecting the reservoir with the water supply and distribution system of Fort Meade.

Fort Meade is a United States Cavalry Post, of a capacity of 8 troops of cavalry. It is situated in Bear Butte Valley, about two miles from Sturgis, South Dakota, and 14 miles from Deadwood, in the same State. The post has been designated as a permanent garrison point, and as a result it is gradually being reconstructed upon modern lines. The old frame buildings of early days are being replaced by permanent structures of brick and stone, designed and built according to the best methods of modern practice. A considerable amount of this construction work has been done within the last few years. That which is now under way and nearing completion represents an outlay of nearly $200,000. The design and construction of the various structures now building are under the general direction of the Quartermaster General, U. S. Army; an army officer is detailed as Constructing Quartermaster in local charge of the work. The writer is employed as Civil Engineer and Superintendent of Construction, under the direction of Major Geo. K. Hunter, 6th Cavalry, U. S. Army, Constructing Quartermaster.

The water supply of Fort Meade is taken from the Sturgis water mains, the point of connection between the town and post mains being at the meter house, situated near the eastern limit of the town. The meter house is a small structure, built at the junction of the two mains, and enclosing two water meters through which all the water flowing into the post mains passes and is metered. From the meter house the water is conveyed through a 6-in. cast-iron main to a 100,000-gallon reservoir situated a short distance south of the post, at an elevation about 100 ft. above the parade ground. From this reservoir 4-in. distributing mains run around the post, furnishing water for domestic use and for fire protection.

FIG. 8. VIEW SHOWING EXPLOSION OF STIGERWALTS' BLAST.

The accompanying map and profile (Figs. 1 and 2) show the location of meter house and reservoir, the route of the water mains and variations in the surface level of the ground.

*Sturgis, So. Dak.

NEW WATER SUPPLY SYSTEM.

On account of the moderate head afforded by the comparatively low elevation of the old reservoir, and the small size of the mains, constituting the old water system, the hydrant pressure and supply was entirely inadequate for fire protection. In view of the necessity of better fire protection for the existing frame buildings and also for the new and costly buildings constituting the reconstructed army post, it was decided to install a new water supply system that would afford a sufficient hydrant pressure to throw two streams of water over the largest building in the post, and at the same time be of sufficient quantity to last through any fire that would ever be likely to occur. Two methods were available for obtaining a supply of water suitable for the purpose required.

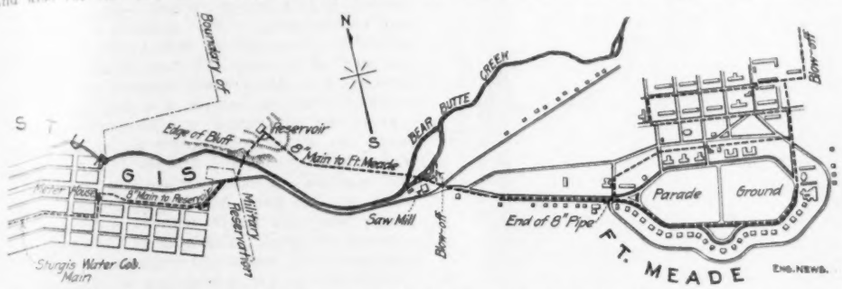


FIG. 1. MAP SHOWING NEW WATER SUPPLY SYSTEM OF FORT MEADE, SOUTH DAKOTA.

One method contemplated an independent water supply, the water to be obtained from a mountain stream in Deadman's Gulch, on the military reservation, about four miles from Fort Meade. This would necessitate the construction of a dam and the formation of a natural reservoir or lake, from which the water would be conveyed by gravity through a cast-iron main to the point of distribution. The alternative plan was to connect Fort Meade with the Sturgis water mains, using a main of sufficient size to furnish an ample supply for both domestic purposes and fire protection. Both methods required the construction of a distributing reservoir of sufficient size to hold a good supply of water and having an altitude high enough to afford the requisite hydrant pressure.

The first-mentioned project was examined and reported on by Mr. J. T. Fanning, M. Am. Soc. C. E., who pronounced it to be entirely feasible. On account, however, of the initial cost and the length of time required to carry out this project, it was decided to adopt the second plan. Should an independent source of water be decided upon, at any future time, the proposed dam can be constructed and a supply main laid and connected with the present main at a point between the meter house and the reservoir, thus forming a connected system which will be in accordance with the original plan.

The plan having been decided upon, specifications were prepared in the office of the Quartermaster General, the work was advertised and proposals invited. The contract for the pipe line was awarded to the Dwyer Plumbing & Heating Co., of St. Paul, Minn. The contract for constructing the reservoir was awarded to Dunnegan & Sykes, of Shenandoah, Ia.

PIPE LINE.

The pipe line comprises, (1) an 8-in. cast-iron main from the meter house to the new reservoir; (2) an 8-in. main from the reservoir to a point near the western end of the parade ground; (3) two lines of 6-in. pipe from the latter point around the parade ground, these in turn connecting with other lines of 6-in. pipe, as shown on the map, all being connected in circuit to afford good circulation. The accompanying profile, Fig. 2, is of the 8-in. mains, and that part of the 6-in. main running around the south side of the parade ground and extending to the extreme lower end of line.

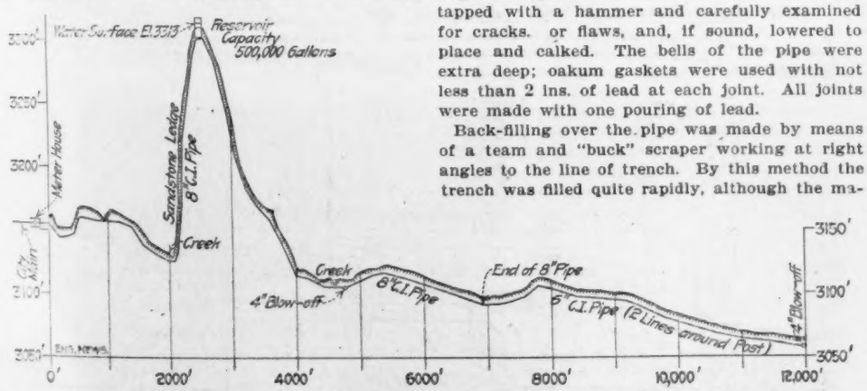


FIG. 2. PROFILE OF CAST-IRON SUPPLY MAIN, FORT MEADE WATER SUPPLY.

DEPTH OF COVER.—On account of the severity of the climate in this locality it is necessary to have a good depth of cover for all water pipes in order to prevent freezing. It has been found from experience that water pipes having less than 5 ft. of cover are liable to freeze in winter, and for this reason a minimum depth of cover of 5 ft. was required for the mains.

METHOD OF LAYING.—The methods employed for laying and covering the pipe were for the most part the same as are generally used for work of this kind. The material encountered in digging the trenches consisted largely of clayey loam on the high ground above the creek bottom. On the hillsides and on the lower portions of the route the material was mainly gravel composed of good-sized stones and fine sand mixed with clay.

The trenches were excavated by hand; after the proper depth was reached the pipe was lowered to place by means of a pulley and sling, working on a movable tripod. Each length of pipe while suspended over the trench was turned to a vertical position to allow any dirt or stones that might have gotten inside, to run out. It was then tapped with a hammer and carefully examined for cracks, or flaws, and, if sound, lowered to place and calked. The bells of the pipe were extra deep; oakum gaskets were used with not less than 2 ins. of lead at each joint. All joints were made with one pouring of lead.

Back-filling over the pipe was made by means of a team and "buck" scraper working at right angles to the line of trench. By this method the trench was filled quite rapidly, although the material was not compacted thereby. Ordinarily the surplus material was heaped up over the trench, but in some places, as around the parade ground, the excavated material was all replaced in the trench, being compacted by flooding.

The route of the pipe line, as shown on the map, Fig. 1, is eastward from the meter house to the public road, thence along the public road to a point about opposite the reservoir, where a change in direction is made and the line run across Bear Butte Creek toward the reservoir. Just after crossing the creek the line ascends a sandstone bluff a vertical distance of about 50 ft. In that portion of the pipe line between the foot and top of bluff, in order to safeguard the pipe against injury from slips and also to secure good cover, a channel was blasted and cut into the rock to a depth of from 6 to 7 ft. below the surface. The pipe was placed in position against the back of the cutting, the changes in direction at bottom and top of bluff being made by means of specials. The accompanying photograph, Fig. 3, is a view of the pipe in position near the top of the cliff, where the upper slope of the hill begins.

After the joints were filled and calked the vertical cut was filled carefully with earth and stone from bottom to top of cliff. The earth and fine material was tamped around the pipe, the coarser material being placed near the surface. The filling was held in place by stone carefully placed by hand on the outside, constituting in effect a dry masonry wall, laid with sufficient batter to insure stability. The remainder of the pipe line up the hill was laid in the usual manner, no special difficulty being encountered in the work.

BLOW-OFF.—A blow-off was placed at the low place in the line near the saw mill; it was laid to discharge into the creek. Another blow-off was located at the lower end of the pipe line, just beyond the last hydrant. Both of these were made of 4-in. pipe; they were connected with the water main by gate valves.

Fig. 3. View of Pipe Line in Trench Near Top of Cliff.

DISTRIBUTION SYSTEM.—The new mains are connected in circuit, thus avoiding dead ends, except at the lower end of the system, where only fire hydrants are to be served and where a blow-off is located. Good fire protection is assured by the number of hydrants installed; there are 41

hydrants, distributed among the various buildings. There are altogether twelve gate valves, so located as to allow sections of the system to be cut out when required without cutting off the flow in other parts of the system.

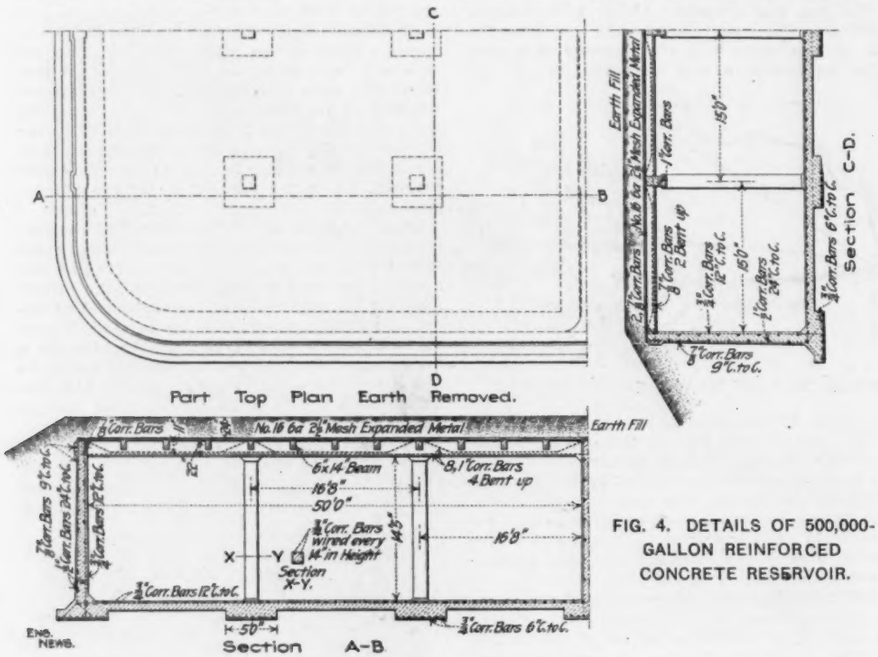


FIG. 4. DETAILS OF 500,000-GALLON REINFORCED CONCRETE RESERVOIR.

CONNECTION WITH OLD MAIN.—A connection of the new with the old main was made at the saw mill by means of a 6-in. pipe provided with a gate valve. In order to allow free circulation between the two mains and at the same time maintain the normal pressure in the old main, a Mueller pressure regulator was installed in the connecting pipe at the saw mill and set for a pressure of 40 lbs. per sq. in.

The two mains being connected in this manner, the post is served with water at two different pressures. The old main still supplies the old buildings at its normal pressure, and the new main supplies the new buildings and furnishes high pressure for fire protection.

TEST.—The new mains were laid and valves and hydrants were installed a considerable while before the completion of the reservoir. The reason for this being that work on the pipe-laying was carried on in the winter when, on account of the temperature, no concrete work on the reservoir was permissible.

The specifications required a test of the pipe line from the head furnished by a full reservoir, but, since this was not available, it was decided to obtain the requisite pressure in the new mains direct from the water company's mains at the meter house. A temporary connection was made in the pipe line at the place where an opening had been left for reservoir connections on top of hill, and the new mains were filled. The pressure regulating valve in the water company's main at the meter house was then opened to allow a pressure of 100 lbs. to show on a gage temporarily attached to the new main at a point just west of the parade ground. This pressure was maintained for 36 hours without any indication of leakage or reduction of pressure shown by gage. A hammer test was given by opening a hydrant to its full capacity and then quickly closing it, subjecting the pipe to the resulting ram.

These tests having been made and the results proving satisfactory, the pipe line was accepted from the contractor.

RESERVOIR.

The reservoir, according to the requirements of the Quartermaster General's office, was to be of reinforced concrete, and to have a capacity of 500,000 gallons. As shown on the general plans furnished to bidders the reservoir was required to contain two compartments, each 50 ft. by 60 ft., and 16 ft. in height from top of floor to under side of roof slab. The corners are rounded and a division wall separates the two compartments, each of which was designed to hold 250,000 gallons when filled to top of overflow pipe. The sides, bottom and roof of this structure were required to be of reinforced concrete, made in accordance with the special construction used by the contractor, to be fully illustrated by plans and described by specifications prepared by him. The roof was required to support a layer of earth 24 ins. thick, and a snow load of 100 lbs. per sq. ft.

The successful bidders, Dunnegan & Sykes, of Shenandoah, Iowa, submitted a design of the St. Louis Expanded Metal Fireproofing Co. of St. Louis, Mo. This design, with some slight modification, was followed out in the construction of the reservoir.

SITE.—The site selected for the reservoir is the top of a hill at an elevation of 200 ft. above the general level of the parade ground. The bottom of the reservoir floor was fixed at about 9 ft. below the ground surface, requiring considerable excavation to attain the proper depth. The material encountered in the excavation consisted mainly of coarse gravel, mixed with material composed of fine sand and clay. This afforded an excellent foundation where confined, as it necessarily was, at the bottom of a deep cutting.

After the excavation was completed the subgrade the entire bottom was thoroughly rolled with a heavy roller and brought to a firm, compact surface. Footing excavations were afterward dug by hand below this surface to the proper size and depth without disturbing the adjacent material. The bulk of the excavation was made with teams and scrapers.

DESIGN.—In Fig. 4 is shown, in plan and section, the design followed in constructing the reservoir. The spacing, and dimensions of the footings, columns and roof girders, the arrangement of the metal reinforcement and, in fact, all the details of the reservoir construction are plainly shown. It will be seen that the system of reinforcement is complete and is amply strong to afford a good factor of safety against any strains likely to come upon the structure.

WALLS, FOOTINGS AND COLUMNS.—The column footings are 5 ft. × 5 ft.; those for the walls are 5 ft. wide and of the full length of the wall. All footings are 12 ins. deep. These dimensions are large enough for stability in the

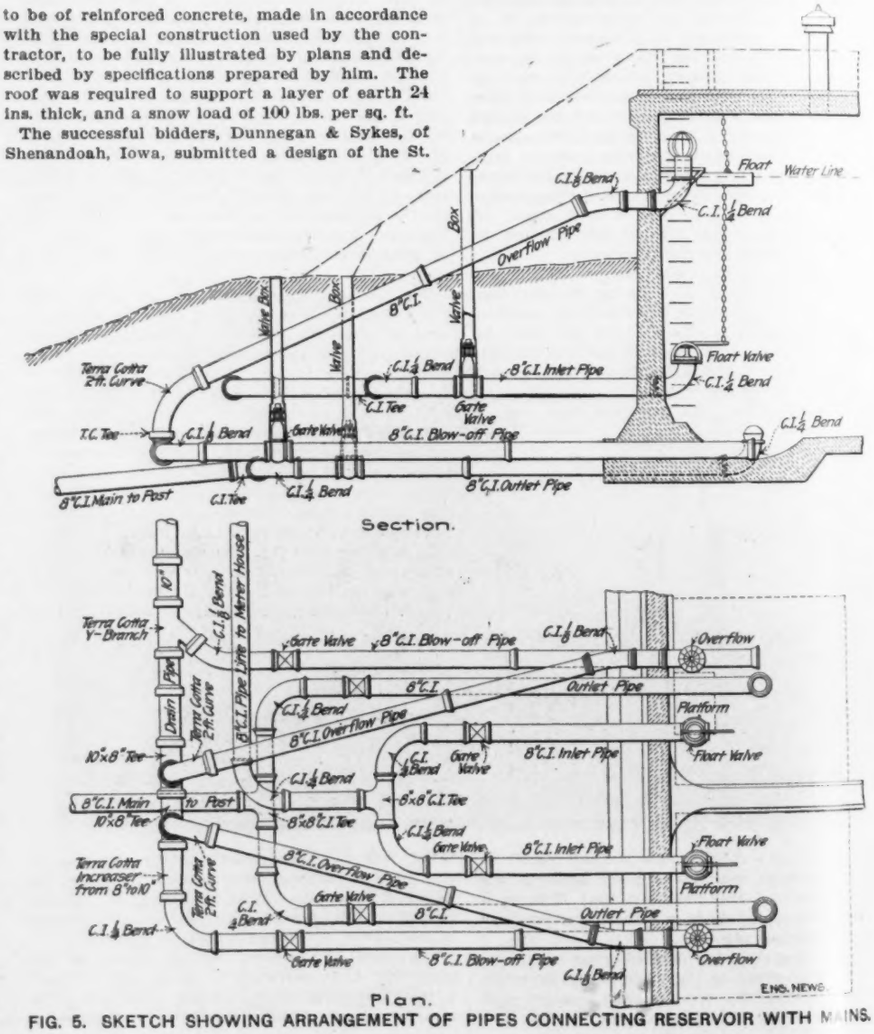


FIG. 5. SKETCH SHOWING ARRANGEMENT OF PIPES CONNECTING RESERVOIR WITH MAINS.

material of the bottom; they have shown no sign of settlement since being loaded.

The columns supporting the roof girders are 14 ins. × 14 ins. in cross-section; they are reinforced by four ¾-in. bars placed vertically one in each corner, and wired every 14 ins. in height. These columns have a rather massive appearance, and are of ample size for the purpose required.

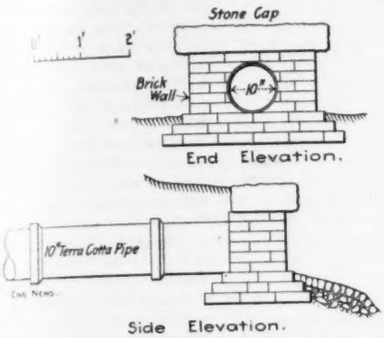


Fig. 6. Details of Head Wall for Terra Cotta Drain Pipe.

The reservoir walls are apparently rather thin for their height. Experience has shown, however, that they are fully adequate for the requirements of watertightness and rigidity.

The roof slab is only 3 ins. thick. It is well reinforced, however, and is supported by roof girders and beams, which are spaced at suitable intervals to afford the requisite strength for the load to be carried, with a good factor of safety. Some apprehension was manifested during construction, by those interested, that the roof because of its thinness would be structurally weak. This apprehension was completely dispelled when the test was made after completion.

PIPE CONNECTIONS.—The arrangement of the pipe connections between reservoir and mains is such that the two compartments can be operated as a unit, or each compartment may be operated independently of the other. This arrangement allows of one compartment being cut off for cleaning, repairs, etc., without in any way impairing the water supply service between the reservoir and Fort Meade.

In Fig. 5 is shown the arrangement of the various pipes provided for the flow of water into and out of the reservoir. The inlet pipes on the main from meter house are provided at their ends inside the reservoir with automatic cut-off valves, operated by floats. The floats are attached to the valve levers by chains, which are made just long enough to close the valve when the water is up to the mouth of the overflow pipe. The overflow pipe is provided as a means of disposing of the surplus water in case the cut-off valve should fail to work properly at any time.

The reservoir end of each outlet pipe to post main is provided with a wire strainer to prevent leaves, chips or other floating trash that might get into the reservoir from entering the main. The strainer is of a sufficiently large superficial area to allow clear space of meshes somewhat larger than the area of cross-section of main. Each overflow pipe is protected in a similar manner by a globe wire strainer, as shown on the plan.

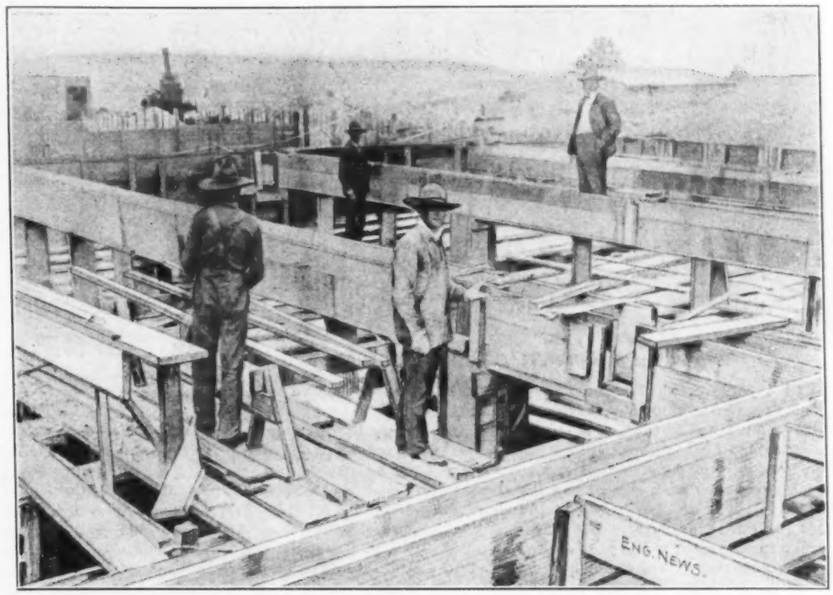


FIG. 7. VIEW OF FORMS FOR ROOF GIRDERS.

All of the overflow and blow-off pipes in the reservoir are connected with a 10-in. terra cotta drain pipe, which discharges at a selected place on the hillside. The lower end of the discharge pipe is protected by a brick end wall, the end of the pipe being guarded by iron bars to prevent entrance of small animals. A detail of this end wall is shown in Fig. 6.

CONSTRUCTION.

Construction work was carried on with much care and every detail was thoroughly executed. Since the reservoir walls were not to exceed 11 ins. in thickness at any point above the floor level and were required to hold without leakage a maximum depth of 13 ft. of water it was important that the concrete composing the walls should be of maximum density and also that the waterproofing should be as efficient as possible.

CONCRETE. — The specifications required "broken stone of hard consistency, not larger than a ¾-in. cube, and clean, sharp sand, the composition of the concrete to be one cement to two sand and four stone." These proportions were used throughout the work.

CEMENT.—The bulk of the cement used in the work was the "Ideal" brand, made by the Portland Cement Co. at Portland, Colo. One other brand was used—the "Sunflower" Portland cement, made by the Kansas Portland Cement Co. at Iola, Kan. Both brands showed up well in tests made by the writer and both gave good satisfaction in the work.

STONE.—It was thought at first that the only variety of stone suitable for use in making concrete was a limestone that was found in a canyon at some distance from the reservoir site. A considerable quantity of this stone was quarried and hauled in wagons to the crusher which was located at the reservoir site. This was quite expensive, as the haul was all up-hill and the roads were poor. On this account it was decided to seek a more accessible source of supply. Upon investigation is was found that a large percentage of the field stone in the vicinity of the reservoir was suitable for use in concrete. From the rounded form and the number of varieties found it was evident that this stone was of glacial drift origin. The native rocks in the bluffs forming the walls of the adjacent canyon and occurring upon the hillsides in large boulders and ledges, is a sandstone of moderate hardness and entirely unfit for use in concrete.

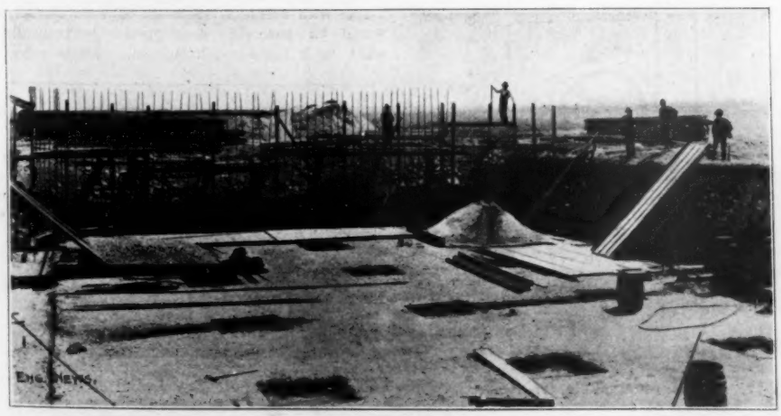


FIG. 8. VIEW SHOWING BOTTOM OF RESERVOIR SITE READY FOR CONCRETING.

The individual field stones, locally known as "nigger heads," were found in various sizes ranging from egg size to a size requiring two men to lift. These were of various kinds comprising quartz, granite, limestone and a small quantity of very hard sandstone. Some pieces of petrified wood were found in the reservoir excavation. All of the varieties of stone named were found on the surface of the ground contiguous to the reservoir site and were gathered up in wagons and hauled to the crusher. Before being crushed all the stone was sorted over and the sandstone that was unfit for use was rejected and thrown aside.

CRUSHING.—Since the crushed stone was required to be of a size no larger than a ¾-in. cube considerable power was required for crushing rock of such a hard nature. A small jaw crusher was first installed and was used for a while. It proved to be inadequate, however, being too light to stand the strain of crushing the harder varieties of "nigger heads." After several sets of jaw plates had been broken and the frame of the machine had been cracked the contractor discarded the small crusher and procured and installed a large gyratory crusher. This proved adequate for the purpose required and did good service throughout the work.

SAND.—The sand was hauled from a deposit which was situated about three miles from the reservoir site. It was a good quality of bank sand; the grains were sharp and of varying size; the percentage of fine grains was, however,

greater than desired. In getting out the sand much care was exercised in removing the surface strippings, the result being a clean sand, practically free from organic matter.

CONCRETE.

The proportions used for the concrete mixture, as has been stated, were: 1 part cement, 2 parts sand and 4 parts crushed stone. As a result of personal experience and observation the writer is a strong advocate of the use of unscreened aggregates in making concrete. Since the concrete used in the reservoir construction was required to be of a high quality with regard to both strength and density it was decided to use in the concrete mixture the entire product of the crusher.

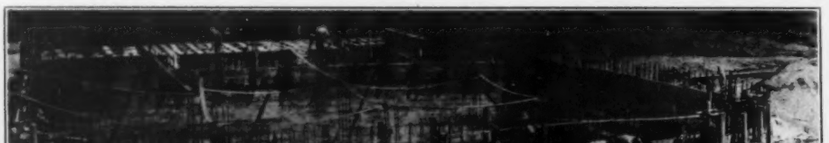


FIG. 9. VIEW SHOWING CONCRETING IN PROGRESS ON RESERVOIR.

In order to ascertain if the proportions required by the specifications were those best adapted to make, with the materials at hand, concrete of maximum density, the writer made careful tests to determine the percentage of voids existing in the sand and the crushed stone. The average of a series of tests gave the following results:

Crushed stone, run of crusher..... 32% voids.
Sand ..... 30% "

MIXING.—The concrete was mixed by hand upon a mixing platform, which was moved from place to place as the work progressed. Measurement of sand and stone was made in iron wheelbarrows, holding 2.5 cu. ft. The cement was furnished in ¼-barrel sacks; each sack of cement was taken as 1 cu. ft.

In mixing the concrete four men were employed and each batch contained the following quantity of material:

4 wheelbarrows of stone = 10 cu. ft.
2 " " sand = 5 " "
2½ sacks of cement = 2½ " "

By referring to the percentage of voids given above it will be seen that this mixture formed a dense concrete, one with all voids filled and with considerable excess of mortar.

The method used in mixing the concrete was as follows:

The sand was first wheeled to the mixing platform and there spread out in a layer about 3 ins. thick. The cement was next spread evenly over the sand and the two ingredients were thoroughly mixed by turning over twice with shovels. The crushed stone, having previously been wetted, was spread evenly over the mixed sand and cement and the entire mass was turned over twice. Water was then added, and the mass was again turned over twice with the shovels and deposited in the forms.

The mixture was made quite wet so as to flow readily and fill all corners and angles in the forms. No tamping, in the sense of ramming, was required, but the concrete after being placed in the forms, was spaded well in order to let out any air pockets that might form, and also to assist the flow of the concrete around the metal bars. Since the space between adjacent vertical bars was not sufficient to allow free use of a spade a tool for spading the concrete was made. This tool was of iron with a 6-in. × 3-in. × ¾-in. blade made on to a handle of ¾-in. round iron, which was about 5 ft. long. This tool was found to be quite useful for working between adjacent bars and between the bars and the inner faces of concrete forms.

METAL REINFORCEMENT.—The footings, walls, columns, girders and beams were reinforced with corrugated steel bars furnished by the Expanded Metal Fireproofing Co., of St. Louis, Mo. The roof slab was reinforced with No. 16 gage, 2½-in. mesh expanded metal, furnished by the same company. The details of spacing and the sizes of the various bars used are shown in Fig. 4. The steel bars were of the standard sizes made by the company furnishing them, with a stated elastic limit of from 50,000 to 60,000 lbs. per sq. in.

CONSTRUCTION METHODS.

STEEL WORK.—The method employed in placing the reinforcement varied according to its location in the structure. In the footings under walls and columns, where reinforcement was required in the lower portion, a thin layer of concrete was first spread over the bottom and the lower reinforcing bars, after being properly spaced, were pressed into the concrete to the required depth. The upper bars were then placed crosswise over the lower ones and were covered with concrete, care being taken not to disturb the position of the bars in the operation.

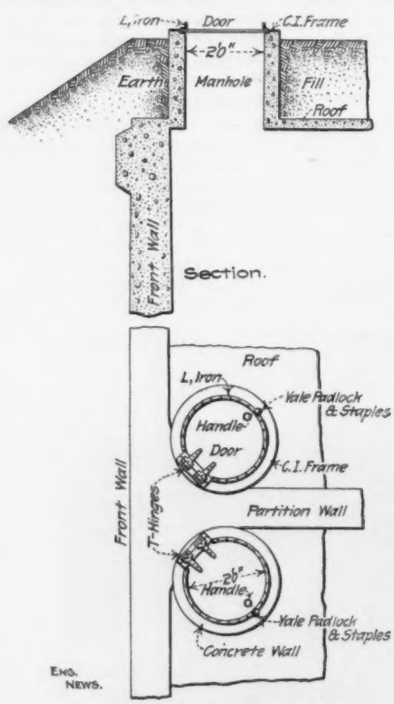


Fig. 11. Details of Manhole for Reservoir.

For the floor reinforcement, after the concrete had been brought to a suitable height, the lower bars were placed in position and the upper bars were then placed crosswise upon them. The two sets of bars were wired together at suitable intervals to hold them in place, while the remainder of the concrete was being placed around and over them.

Before concreting the walls and columns the reinforcement was erected in place, forming a steel skeleton around which the concrete was placed. In the columns the four vertical corner bars were held at the proper distance apart by wooden plates, through which holes had been bored to receive the bars. These plates were moved up out of the way as the concreting progressed. The column bars were wired together every 14 ins. in height, the wiring being done ahead of the concrete work. The top of each column skeleton was stayed by plank braces secured to adjacent columns and to wall forms.

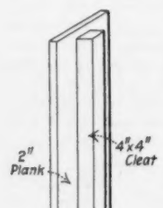


Fig. 10. Sketch of Stop Board.

The vertical bars in the walls were spaced by means of planks, forming templets through which holes had been bored at proper distances apart to receive the bars. Each row of bars was spaced by an independent templet, which was moved upward as the concrete work progressed, and which was always kept high enough to allow room below for placing and tamping the concrete.

Those bars placed horizontally in the walls were held in place by being wired to the vertical bars. Each bar was secured in place as needed, after the templet had been raised high enough to make room for it. The bars used in the girders were held at the proper elevation in the concrete by being blocked up, the blocks being removed as the work progressed.

The expanded metal used for reinforcing the roof slab was laid directly upon the centering and, after being covered by some concrete roughly shoveled over, was raised slightly by means of hand hooks so as to insure the expanded metal being slightly above the bottom of the slab and at the same time entirely enclosed in concrete.

None of the metal was painted and no special precaution was taken to avoid slight rust. No metal was allowed to be used if covered with rust scale, but slight discoloration from rust was not considered objectionable. If a bar was found to have rust scales upon it these were removed with a wire brush before the bar was used in the work. There were, however, very few bars affected with rust scale requiring removal.

FORMS.

The concrete in the footings was deposited in forms made by placing boards edgewise inside the excavations, which were made just large enough for this purpose.

The wall forms were made of 2-in. planks, surfaced on one side and placed horizontally on edge, with the smooth side in. These were held in place by 4 × 4-in. posts spaced at intervals of about 4 ft., in pairs on opposite sides of the wall. The posts were secured in place by outside struts and by connecting wires passing through the wall space between the edges of adjacent planks.

Fig. 12. Practical Test of Reservoir Roof by Hauling Covering with Teams.

In turning the rounded corners of outside walls the forms were made of thin, narrow boards, sprung to the proper curve and held in place by posts at 2 ft. intervals. At the junction of the partition wall with the outer walls the rounded

corners were turned by using a form shaped like a segment of a drum or cylinder, whose face was a quadrant with a 2-ft. radius. This form was made by nailing vertical wooden strips to horizontal arch ribs. It was secured in place with each end of its quadrant shaped face tangent to the face of the adjacent wall form and then firmly braced.

The column forms were made of three side pieces extending from floor to girder, the fourth side being left open to receive the concrete. These forms were braced at the bottom by struts extending on all four sides to firm bearings. At the top they were held in place by braces extending to adjacent columns and to the walls.

The girder forms were open troughs or channels of the requisite dimensions, made of 2-in. plank with the smooth side in. The forms for the beams were of the same character but smaller. A photographic view showing the general appearance of these forms while under construction is shown in Fig. 7.

In preparing the roof forms or centering a close floor was made of 2-in. planks with smooth side uppermost. The centering and the girder and beam forms were well supported by posts resting upon the floor below.

CONCRETE WORK.

Fig. 8 is a photograph of the work just before commencing concreting. The concrete was mixed by hand upon a movable mixing platform. Part of the time two mixing gangs were employed, but this was only when the carpenters were sufficiently ahead with the forms to allow plenty of room for placing the concrete and in concreting the footings and the floor where forms were not required. Most of the time, however, only one mixing gang was employed, this being sufficient to keep pace with the erection of the forms. The comparatively slow work on form building was due to the scarcity of carpenters, it being difficult to obtain a supply of skilled labor in this remote locality.

A mixing gang consisted of four men, who filled their barrows at the supply piles, wheeled the material to place and deposited it upon the mixing platform. They then mixed the concrete, in the manner previously described, and deposited it in the forms. Fig. 9 is a photographic view showing the mixing gang at work. One man was required to tamp the concrete in the forms, using the tamping tool previously described. The concrete was mixed wet and was deposited in the forms by shoveling direct from the mixing platform. The walls were built up, as nearly as practicable, uniformly all around. No part of the wall was carried up higher than 4 ft. above any adjacent part. The wall forms were built up one plank at a time to conform to the progress of the work as the concrete advanced in height. At places where concreting was stopped for the night or over Sunday, or where work was temporarily discontinued, stop boards were used to square up the ends of the concrete work. These boards were placed vertically, they were not over 4 ft. in height and of the full width of the wall space. In Fig. 10 is shown the construction of a stop board such as was used in this work. It was made of a 2-in. board, to the center of whose face was spiked a vertical 4-in. × 4-in. cleat as shown. When placed in position the board filled the wall space from side to side and the cleat faced the fresh concrete work. The effect of this was to form a vertical recess or mortise in the end face of the concrete wall into which the fresh concrete, placed for the continuation of the wall, would flow and form a tenon or tongue, thus making for watertightness and avoiding a plane of weakness at the junction of the new and old concrete. There were only a few vertical joints required in the work. The practice was to deposit the concrete in horizontal layers entirely around the enclosed space, each compartment being considered as a unit.

At all places where fresh concrete was joined to old work, all loose material was removed and the surface of the old concrete was washed clean and then covered with cement grout before depositing the fresh concrete.

In order to obtain a smooth surface for the outside faces of the reservoir walls, the concrete was spaded back from the corresponding faces of the wall forms to allow the fine material to flow in and settle next to the face of form.

For the inside faces of walls no effort was made to obtain a smooth surface; this was preferably rough to afford a good bond for the plaster finish required by the specifications.

In placing the concrete in the forms every effort was made to secure a product of maximum density. The result, as shown by test, proved the efficacy of the methods used to accomplish this purpose.

In concreting the roof girders and beams each such member was made complete at one operation. The roof slab was carried forward to its full thickness of 3 ins., the concrete being deposited continuously over as large an area as possible. In stopping work for the day care was taken to leave off concreting directly over the axis of a girder and with an inclined face.

REMOVAL OF FORMS.

No particular length of time was specified for leaving the forms in position after the concrete had been emplaced. The wall and column forms were left undisturbed for a period of from 7 to 10 days after concreting before removal. After that time such lumber as could be used in other parts of the work was carefully removed. The girder forms and roof centering were allowed to remain in place from two to three weeks before being taken down. The roof and girder forms were so constructed that they could be readily removed without shock or disturbance to the structure above them.

After the forms were removed the wire ties that had been used for holding the wall forms together were clipped off about ½ in. below the surface and the resulting holes in the concrete were filled with cement mortar.

WATERPROOFING.

The specifications required that, after the concrete work was completed, the floor and the inside surface of reservoir walls were to be covered with a coating of cement mortar, composed of one part Portland cement and one part sand, to be put on evenly and troweled true and smooth.

The writer is convinced that the best method of securing a good mortar finish on the surface of a vertical concrete wall is to place the required quantity of mortar against the face of the form at the time the concrete is deposited, thus forming a single piece of the two. The contractor preferred, however, to plaster the walls after removing the forms and, since this practice did not conflict with the specifications, it was allowed. The plastering was required to be carefully applied in two coats and a good job was made of it. On account of the richness of the mortar a few surface cracks appeared upon drying; these were gone over with a coat of grout, applied with a brush. The floor finish was laid in alternate strips, using a straight edge to level the top. After the first laid strips had hardened the remaining strips were filled in, the edges being first grouted to insure tight joints.

The outside of walls and roof were covered with a coating of tar applied hot. The tar was heated to a temperature of about 360° F. and was then applied as rapidly as possible with a stiff brush and well rubbed in until the entire surface was covered.

MISCELLANEOUS.

MANWAYS.—Access to each compartment is had through a circular manway of 2 ft. diameter, having a trap door of No. 10 boiler plate, set in a cast-iron frame. Below each trap door is a flight of ¾-in. round stepping irons firmly set in the concrete and extending to reservoir floor. The manway extends to top of earth fill, two feet above reservoir roof. Details of manway covers are shown in Fig. 11.

EARTH COVER.—The entire structure, after completion, was covered with earth to a height of 2 ft. above roof, sloping on all sides to the natural surface of ground. The earth composing this fill was moved by means of teams and scrapers, which method caused the earth to be compacted firmly in place and at the same time afforded a good test for rigidity and strength in the roof.

VENTILATORS.—Ventilation is effected by means of 8 "Star" and "Globe" 10-in. ventilators, set in the roof and extending well above top of earth cover.

PLATFORM.—In each compartment was placed a 3 ft. × 3 ft. iron platform, in the position shown in Fig. 5. Each platform was supported on brackets built into the concrete and firmly held in place by wire clips attached to brackets.

TEST.

The specifications required that the roof should be built to support a layer of earth 24 ins. thick and a snow load of 100 lbs. per sq. ft. During its construction, as previously stated, some comment was made by interested observers upon the thinness of the roof slab and doubt was expressed as to its stability. In order to allay any such apprehensions and at the same time make a test that would demonstrate its strength beyond question it was decided to have the earth cover hauled upon the roof by means of teams and scrapers. Fig. 12 is a photographic view showing four teams with loaded scrapers upon the roof at one time. This was considered a satisfactory test of strength since there was no vibration apparent at the time and no evidence of weakness.

In the test for watertightness that portion of the earth filling around the inlet and outlet pipes was left out and both compartments were filled with water up to the overflow pipes. The reservoir was then left undisturbed for 36 hours and a careful examination made for evidences of weakness. There were apparent in the exposed wall face near lower pipes two damp patches about four square inches in area. These did not enlarge in size after continued exposure and did not exude water. The water level in the reservoir was not lowered appreciably after standing for the time mentioned, indicating no loss from leakage. Next, the water in one compartment was expended, partly through hydrants in Fort Meade and partly through the blow-off pipe, the other compartment being left full of water. The empty compartment was then entered and the surface of walls closely examined, particularly the division wall between the two compartments. This was found to be in good condition and so free from moisture that a match was struck upon its surface. The empty compartment was then refilled and the other compartment was emptied and examined with the same satisfactory results. The reservoir was then considered completed and was accepted from the contractor.

GENERAL.

Throughout the entire period of construction no pains were spared to have all the work done in a thorough and workmanlike manner. The writer's efforts in this direction were ably and conscientiously seconded by the contractor and his representatives on the ground and much credit is due them for the successful and satisfactory results obtained.

Mr. C. E. Briggs was superintendent for the contractor, and Mr. N. N. Irwin looked after the purchase of material and the payment of labor.

COST OF WORK.

Through the courtesy of Mr. Irwin the writer has been enabled to obtain itemized statements of cost of labor and material required for the entire work. On account of the isolated location and its distance from markets the cost of construction material was high. The cost of labor is high, ordinary labor commanding $2.50 per day of 10 hours and teams $5 per day. The men employed in mixing concrete were paid $2.75 per day. Cement was purchased in carload lots. That purchased during the latter part of the work for plastering cost considerably more than that purchased earlier and used for concrete.

Sand was obtained by contract from the owner of the sand pit at a price of $1.80 per cubic yard delivered at reservoir site.

Cost of concrete in footings, walls, columns and girders. Cost of each item per cubic yard of concrete in place:

Crushed stone	$3.108
Sand	0.842
Cement	3.859
Reinforcement	4.959
Forms	2.960
Labor mixing and placing	1.721
Miscellaneous	0.231
Total	$17.740

Cost of concrete in roof slab:

Expanded metal reinforcement	$5.241
Other items, same as above	12.781
Total	$18.022

Plastering inside walls, per cubic yard of plaster in place:

Cement	$12.68
Sand	1.20
Labor	7.42
Total	$21.30

Waterproofing outside walls and roof, per square yard. Total cost of tar and labor, 4 cents per sq. yd.

Excavation	49 cents per cu. yd.
Earth fill	30 " " " "

SOME NEW FEATURES IN STEAM SHOVEL DESIGN.

In steam shovel design there is practically one general type, and all makes of steam shovels are very much alike except in matters of detail. We have, however, had occasion to describe some machines differing essentially from the general type, and another machine of special and novel design is described below. The first of the machines to which we refer is the Thew steam shovel (Engineering News, April 11, 1901). This employs wire cables for the hoisting and swinging motions, and has a telescopic boom pivoted to a carriage having a horizontal travel on a frame carried by the boom, so that the point of rotation of the dipper is close to the work when making a cut. The Kilgore steam shovel (Engineering News, Dec. 17, 1903) has no cables, chains or gearing, but is operated entirely by direct-acting steam cylinders. The Robinson steam shovel (Engineering News, Aug. 4, 1904) has as its special feature the use of a wire cable instead of chain, led direct from the drum to the dipper without the usual sheaves or block-and-tackle arrangement; the dipper, also, is made without a bail, the rope being attached directly to the back of the rim of the dipper.

In the new design of steam shovel which we describe below the following are the principal special or novel features: 1, The use of wire ropes instead of chains, and a differential drum (of two diameters) carrying a single large rope from the hoisting engine and two smaller ropes to the dipper; 2, A direct lead from the drum to the dipper without any multiplying sheaves or tackle blocks; 3, A dipper without a bail; 4, An upward lift exerted on the turntable, facilitating swinging and consequently tending to increase the rapidity of work; 5, A reduction in the amount of gearing; 6, A bearing on the tires of the wheels of the front truck to give steadiness when working.

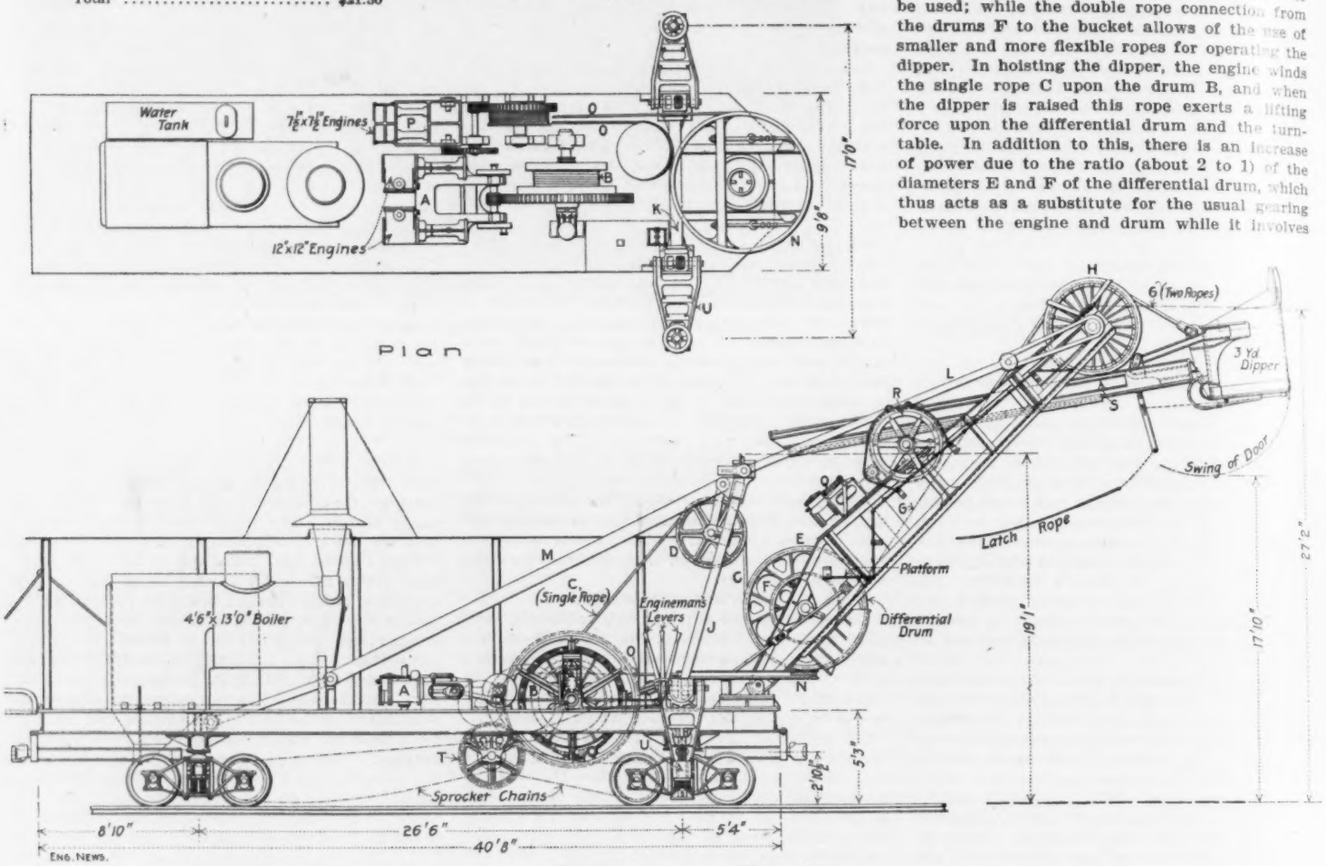


FIG. 1. A NEW DESIGN OF STEAM SHOVEL OPERATED BY WIRE ROPES.
Allis-Chalmers Co., Milwaukee, Wis., Builders.

In Fig. 1 are given the plan and elevation of a 70-ton steam shovel of this type, having a dipper of 3 cu. yds. capacity. The car is of steel construction throughout, including the housing over the boiler and engines. Both the hoisting and swinging engines are mounted on the car, and the turntable is thus relieved of the weight and vibrations resulting from the plan sometimes followed of placing the hoisting engine on the turntable. The hoisting engine, A, has two cylinders 12 x 12 ins. (said to be larger than the engines usually employed on a machine of this size), and is geared directly to the drum, B, without the use of a jack shaft or countershaft. The hoisting rope C is carried from the 44-in. drum B over a sheave D at the head of the A-frame, and then down to the differential drum E, to which the end of the rope is fastened. As the sheave D is in the axis of revolution of the turntable, there is no trouble due to the swinging of the boom. The differential drum consists of a central portion, E, of large diameter, and two side drums F of smaller diameter, all formed in one piece. The single rope from the engine is attached to the larger section, while to each of the two smaller sections is attached a wire rope G which passes over the large double-grooved head sheave H and is fastened by a pin connection to the back of the bucket. The large drums B and E allow a single wire cable of ample diameter and strength to be used; while the double rope connection from the drums F to the bucket allows of the use of smaller and more flexible ropes for operating the dipper. In hoisting the dipper, the engine winds the single rope C upon the drum B, and when the dipper is raised this rope exerts a lifting force upon the differential drum and the turntable. In addition to this, there is an increase of power due to the ratio (about 2 to 1) of the diameters E and F of the differential drum, which thus acts as a substitute for the usual gearing between the engine and drum while it involves less loss by friction than in the gear. The speed of both the dipper and the rope is 109 ft. per minute, with the drum B making 17 revolutions per minute.

The A frame, J, is a single forging, with its feet set in sockets on a tension bar, K, while the head is fitted with a cast-steel cap having the attachments for the sheave D, the boom guys L, and the back-stay M, which is anchored at the rear bolster. The turntable, N, is operated by a cable, O, from the drum of the swinging engine P, which has two cylinders 7½ × 7½ ins. The boom is 25 ft. long, of plate girder construction, heavily braced to resist lateral stresses and having cast steel end pieces. Upon it are mounted the crowding or dipper engine Q (having two cylinders 7½ × 7½ ins.) and the shaft which car-

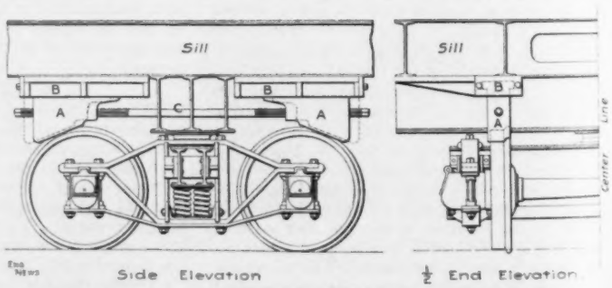


FIG. 2. SIDE BEARING ON WHEELS FOR STEAM SHOVEL.

ries the brake drum R and the pinion gearing with the rack on the bottom of the dipper handle S. The bearings of the differential hoisting drum are placed within the girders, instead of being simply attached to the top chord of the boom, so that there is no shearing strain on the bolts which fasten the boxes to the boom. The boom has a normal angle of 40°, and gives a total clear lift of 17 ft. 10 ins. from the rail to the bottom door of the bucket when open. For a greater lift or reach the angle or length of boom can be changed as desired.

The machine has a boiler of the locomotive type, carrying 100 lbs. pressure and giving a mean effective pressure of 75 lbs. per sq. in. It is self-propelling by means of sprocket chains to the inner axle of each truck. The shaft carrying the driving sprockets is driven from the swinging engine through the gear wheel T. When the engine is to be hauled by a locomotive, the chains are disconnected. Automatic M. C. B. couplers are provided to enable the machine to be coupled to a locomotive or to a train. All the clutches are actuated by steam, and are controlled from a group of levers at the front of the machine, where the engineman has a good view of the work. The dipper engine is handled from a platform on the boom.

One special feature remains to be noted, and that is the side bearing on the truck wheels, which is shown in Fig. 2. The machine has the usual jack arms (U, in Fig. 1) to increase the base of support in making side lifts, but very frequently the blocking settles or is not tightly wedged up under the jacks, so that the machine has a rocking or tilting motion before the jack arm comes to a bearing. In the arrangement shown in Fig. 2, the side bearing is supplemented by blocks A, A, fitted between the truck wheels, and bearing plates, B, B, under the sills. A single screw C draws the two blocks together to a bearing on the wheels, or releases them sufficiently to allow the wheels to revolve as the machine is moved ahead, when they are again brought to a bearing by a partial turn of the screw. In this way the front end of the machine has a rigid bearing upon supports about 5 ft. apart, thus tending to give exceptional steadiness in working.

This new style of steam shovel has been designed and patented by the Allis-Chalmers Co., of Milwaukee, Wis., which is now preparing to build the first machines. The same method of cables and differential drum is also to be applied to dipper dredges.

THE DECORATION OF CONCRETE WITH COLORED CLAYS.*

By Henry C. Mercer.

When I found the facility with which permanent, weather-proof color could be burned into clay, and realized the tensile strength of the recently improved cement more or less reinforced with iron, I saw how large clay pictures or mosaics could be made, not as in the old Roman method or other previously known ways, by building up the design with minute tesserae, but by boldly cutting it out of slabs of colored clay. Burn the latter, reassemble the burnt pieces as you would the units of a stained glass window, drop them into a bed of cement and you have a mosaic.

Because the process lent itself to bold designs on a large scale, and because of the fire and weather-proof character of cement and clay, the method appeared particularly adapted for the decoration of pavements and the inner or outer walls of brick, stone or cement buildings.

Patterns ranging from 1 ft. to 20 in diameter, or even where the figures of men or animals might equal life size, consist of pieces of clay burned in many colors superficially or throughout the body, and either glazed or unglazed. The tesserae, not rectangular as in Roman or Byzantine mosaics, but cut in multiform shapes to suit the potters' process, and whose contours themselves help to delineate the design, are set in cement at the pottery. Just as in the leaded glass designs of a stained window, bands of lead holding together the glass units, form the pattern, so here the cement remaining visible around the circumference of each piece presents the outline of the picture. Thus you have a picture drawn in outlines of cement with clay colors set between the latter. I paint my pattern with clay paint. But I draw my outlines with your cement. Consider your cement, then, from two points of view as I apply it, first, artistically, and, second, practically, to my decorative work. For whether I insert my mosaics into a brick wall or wall of concrete, my drawing is done in cement and produces its effect, over and above my abilities to draw, first, by the color of these outlines and next by their shape and size. From my point of view the complained of gray of the cement is no misfortune but a favor. In its neutral color it tones with any hue. So, as far as the outlines are concerned, it can often be let alone. I have tried to color it for red, blue, green, yellow or white outlines, but finding that all are more or less artistically injurious or restless, I have preferred to stain these lines in the black that old woodcuts have guaranteed, or let the gray or gray-white of the cement produce its own effect.

Try how far you dare go in the width of outline in any drawing and you will be surprised. A law seeking to reveal itself seems to command that the farther you recede from the realistic picture and the nearer you approach the conventional design, that is the less pictorial and the more architectural you become, the wider you may make your outlines. Look and judge still further, for, what would be too wide for a flower pot or door lintel, would be over-thin on a frieze 50 ft. from the ground. Higher still you might want your outline as thick as your leg in drawing colossal human figures. It is a question of distance. The human eye focuses a pavement mosaic at about 5 ft. Consequently, by this need, the marble floor pictures in the cathedral at Sienna are too large. You dare not make your pavement mosaic more than about 6 ft. in diameter, with outlines not much over one-half or three-quarters of an inch wide.

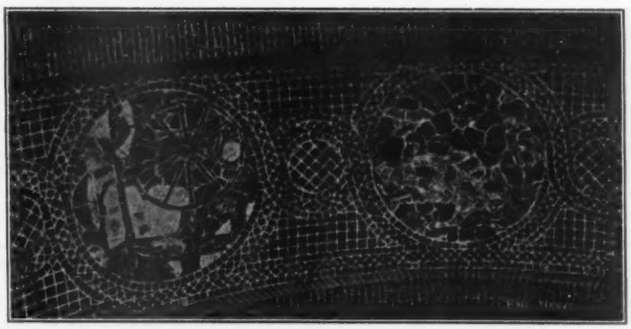
Drawing these outlines always in cement, there is another way of strengthening them in walls if not upon pavements other than by staining them black, and that is by depressing their pointing about a half inch below the level of the picture. Then you have a luminous line, light rimmed, with shadows creeping in and out of its intaglio. Let it be added that many of the lines on these mosaics are not outlines at all, because they diverge eccentrically and do not develop the design. This comes of the potter's law, which discourages the burning of slabs of clay much larger than a foot in diameter. You might or could burn them larger than this, but your craft, if true, would rather avoid technical difficulties than seek them. Thus your picture becomes mysterious. The design recedes behind a network of cross cuts and eccentric joints. But no more so than in the case of the stained glass window of the fourteenth or fifteenth century. The design having become a secondary thing, both in the window and mosaic, we may not at first see it. Stop and puzzle it out if you wish. If not, pass on, but be satisfied with the color. It is a great failure if not decorative.

Turning to practical things, how get these many pieced, sometimes colossal pictures, too heavy to paste on paper or canvas, destroyed to the uninitiated if disjointed, into a building? You can slab them in cement in sections at the pottery and transport the slabs, thanks to your improved cement. You can set them piece by piece against the wall, in which case hollows should be cast for their reception, or you can cast them direct into a pavement or ceiling. In the latter instance lay your pieces face down on the mold as was done in the case of the arch soffit adorned with mosaics represented in the photograph. Then, when the concrete of the arch was poured over the clay pictures they became an integral part of the building itself.

If you please, glaze the mosaics. But it remains to be seen whether the body burned clay colors, having passed through the same fiery ordeal as the cement itself, do not harmonize with the latter better than a superficially colored glaze. In the new feat of constructing whole buildings out of cement, I would like to speak as though we proposed not to copy stone or wood or metal, or anything else, but as though we intended to let the cement stand upon its own merit, casting itself into any reasonable shape, by and for its own law.

Avoiding wood, the mosaics might set against brick, stone or plaster, while most of all, the designer might be interested in placing them upon the soft, neutral background of your cement. And in saying so I would protest against the man who, for artistic reasons, plasters a concrete wall. As at the freshly cast vaulted ceiling of the library cloister at Bryn Mawr College, as upon the cornice of Jacob Reed's Sons' building on Chestnut St., in Philadelphia, before it was plastered, or upon the interior columns of the same building before they were masked with stucco, I would suspect that the board-welted, pumice-like texture of your heavily slagged concrete, simulating from the start the rub of time and mellowing of ages, would best harmonize with the fire colors of the clay.

*Paper read at the Quarterly Meeting of the Association of American Portland Cement Manufacturers, Niagara Falls, N. Y., Sept. 12 and 13, 1905.



VIEW OF SOFFIT OF A CONCRETE ARCH DECORATED WITH COLORED CLAYS.

EXPERIMENTS ON THE MANUFACTURE OF WHITE PORTLAND CEMENT.

By Charles Delavan Quick.*

White cement of a strictly Portland character has recently come to be recognized as something more than a possibility. The investigations on the constitution of Portland cement, which the Messrs. Newberry made a few years ago, and the recent notable researches of Mr. Clifford Richardson along the same lines, have brought out this fact very clearly. These gentlemen, however, at the time of their experiments, made white cement, but incidentally to their theoretical work. They of course used chemically pure materials, and they employed a degree of fineness previous to burning and other conditions which would be entirely out of the question for practical purposes. The writer, keeping in mind the natural limitations of the processes used in manufacturing cement commercially, has endeavored in all experiments to adhere as closely as possible to conditions practically attainable with modern cement machinery.

The conditions necessary for making white Portland cement are similar to those required for making ordinary Portland cement. But more than with the latter the important factor is suitable raw materials, for the absence of color in the cement is almost entirely dependent on their inherent properties; that they have a very low content of iron is absolutely imperative. Iron has often been called an unessential constituent of Portland cement, but it plays such an important part in helping to bring about the combination of the essential elements silica and lime, that, though of secondary importance, it must be considered essential to the economical manufacture of ordinary cement. Cement to be white cannot contain more than 0.80% Fe_2O_3, so practically speaking the problem of making white cement narrows itself down to securing raw materials containing very little iron, and modifying regular processes so as to produce stable clinker, without the aid of that element in bringing about the reactions which take place in the kiln.

Raw materials suitable for making cement and free from or containing a very small amount of iron, are by no means plentiful; and locations where both the necessary calcareous and silicious elements exist are still more difficult to find. The writer has examined limestones and clays from many different states, and in only three instances were the proper materials found in close proximity. In many cases the difficulty lay in the clay containing too high a proportion of alumina, which of course could not be corrected

*Cement Expert, Ironton, Ohio.

without the presence nearby of sand or some other highly silicious material, also free from iron. By free from iron in this connection is meant, for limestone not over 0.2% Fe_2O_3, and for clay not over 0.75% Fe_2O_3. Of course, limestone and clay for this purpose, as for making any Portland cement, must contain but small amounts of magnesia and sulphur. The proportion between the silicia and the alumina in the clay base should not be less than 3 to 1 or more than 4 to 1; and the combined percentages of silica and alumina not over 88.5% of the whole clay base.

Having secured the proper raw materials, if it were practically possible to grind them sufficiently fine, and the temperature of the kilns could be kept high enough to bring about complete diffusion, then simply following the well known formula X ($Si O_2$ 3 Ca O) +Y (Al_2O_3 2 Ca O) would produce the desired white cement. However these conditions are not attainable when handling larger amounts than those sufficient for experimental purposes. Not appreciating just this point many experts failing to get practical results concordent with the above formula, have unjustly criticized it. On the other hand industrial clinker of as high basicity as required by this formula is practically never found, which is one of the strongest arguments in favor of Mr. Richardson's new formula, and ideas in regard to the constitution of Portland cement. In order, if possible, to discover the degree of basicity which could be maintained in making white cement, in which the fluxing agents are necessarily low, and under conditions within the reach of the present processes, a series of mixtures were prepared of gradually decreasing basicity.

With a raw mixture ground all to pass the No. 200 sieve and a temperature of 1570° C. it was found impossible to produce stable clinker corresponding to the formula X (SiO_2 3 CaO) + Y (Al_2O_3 2 CaO). When, however, the following composition was reached the clinker was perfectly stable,

	Per cent.
SiO_2	22.60
Al_2O_3	7.01
Fe_2O_3	.71
CaO	67.37
MgO	1.26
Na_2O	.26
K_2O	.49
SO_3	.30

With a higher proportion of alumina a more basic cement might be produced, but aluminous cements are as a rule apt to disintegrate when subjected to changes of temperature, and are generally unsatisfactory.

Calculating the molecular ratios of the constituents of this cement by dividing the percentage of each by its molecular weight, and each again by such a figure as to make that for silica unity* the chemical relationship is brought out more clearly.

	Per cent.	Molecular ratio.	
Silica	22.60	.37417	1.0000
Alumina	7.01	.06872	.1836
Iron	.71	.00444	....
Lime	67.37	1.20303	3.2946
Magnesia	1.26	.03150	
Potash	.49	.00521	....
Soda	.26	.00419	....
Sulphuric anhydride	.30	.00375	....

Neglecting the iron and sulphur, and the alkalies (it will be noticed the sum of the molecular equivalents of the former almost equals that of the latter), and assuming all the silica to be in the form of trisilicate, there remains but .2946 Mo. (Mo. equals CaO + MgO) to be in combination with .1836 Al_2O_3; or 1 Al_2O_3 to 1.60 Mo. Evidently if all the silica exists as trisilicate then the Al_2O_3 must be less than dibasic. There is probably a certain proportion of disilicate present.

$$\frac{\text{Mo.}}{Si O_2 + Al_2 O_3} = 2.78,$$

which may be called the basicity of the cement. This clinker was well sintered and of a very light yellowish green color. When ground 85% to pass the No. 200 sieve, it made a perfectly white cement, which with the addition of 2.5% of gypsum attained an initial set in one hour, hardened well, and was perfectly volume constant in cold and hot water. Made up with three parts standard sand it developed a tensile strength in seven days of 448 lbs., and in 28 days of 620 lbs. per sq. in.

As before stated it was found impossible to produce stable clinker with a higher basicity than 2.78. That is with the fineness and temperature mentioned, which certainly are very near the limits attainable in practice. The phenomenon of dusting, or immediately falling to a powder of almost no hydraulic properties, invariably took place. This the writer attributes to *incomplete diffusion* due to insufficient surface contact area for the temperature and basicity. In a recent article published in "Cement and Engineering News" for July, Mr. Richard K. Meade claims that the trouble many experimenters have experienced with dusting is caused by the reducing action of the small furnaces which they use, and that dusting never takes place in clinker burnt in the rotary kiln. The writer has, however, often seen pieces of clinker burnt in a rotary, which dusted immediately on cooling, and also clinker which had every appearance of having been acted on by a strongly reducing flame, which was perfectly stable. It was noted also that the pieces of industrial clinker which dusted, invariably had in their center, portions of unburnt material of a very coarse nature, which goes to show that if the mix had been properly ground and the temperature sufficiently high these unstable clinkers would not have been formed. Mr. Richardson says in this connection:

> If the surface area of the different particles entering into the formation of a clinker is not great enough to provide a sufficient area of intimate contact for diffusion to be complete at the available temperature and in the allotted time, so that the resulting clinker is homogeneous in constitution, the latter will not be in equilibrium or volume constant. This is a matter of great importance in the production of Portland cement, and together with the temperature and duration of heating makes up the conditions which must be carefully regulated in order to produce a stable clinker; that is to say to bring about complete equilibrium, without which a clinker on cooling would tend to rearrange its structure and dust.

The above has particular bearing on the manufacture of white Portland cement, for the chief function of the iron in ordinary cement is to aid in bringing about complete diffusion, thereby insuring a homogeneous and stable clinker. In the absence of iron it will be found necessary to have a greater area of surface contact between the particles of the raw mixture, and the temperature required for burning will undoubtedly be found to be higher than that now generally employed in rotary kilns.

The uses to which white Portland cement could be applied with advantage are manifold. Its superiority to Keen and other so-called non-staining cements, and plaster of Paris is evident, when it is understood that it has all the durability of ordinary cement, being perfectly resistant to the action of water and atmospheric conditions. The manufacture of artificial marble from cement is being developed with great rapidity, but only dull colors have been attempted, because of the lack of a colorless non-staining base. With white cement it would be possible to produce brilliant colors and any tint or shade desired by addition of proper stains. In fact, once having a base free from color it is by no means out of the way to predict the production of colored cements dyed in the wool as it were. In the writer's laboratory small samples of deep blue colored cement have been made, also a very pretty pink. This is a most interesting phase of cement work and an attempt is being made to investigate it along industrial lines, as with the white Portland cement.

Concluding, it may be said in regard to the production of white cement on a commercial basis, that it would not necessarily be much more expensive than making ordinary cement. In preparing the raw materials great care would have to be taken to insure the proper basicity as the margin of safety is very small. The mixture must be ground finer than is customary for ordinary cement, and a higher kiln temperature is required, with the direct use of coal excluded, but with the most modern and improved machinery it would be possible to overcome these difficulties and produce the finished article at a cost very little, if any, in excess of that for which ordinary cement is made in many mills to-day.

*Ludwig's method.

FOUR VARIETIES OF WATER PRESSURE REGULATING VALVES.

Four varieties of water pressure regulators were described in a paper presented to the New England Water-Works Association on Dec. 13 by Mr. A. O. Doane, Division Engineer, Metropolitan Water-Works, Boston, Mass. The complete paper, which included some general remarks on pressure regulators and their use, will be printed in the Journal of the Association. We are enabled, through the courtesy of the Association, to abstract a portion of the paper and to reletter and reproduce the illustrations accompanying it. The four regulators described are the Ross, Mueller, Union and one designed for and named after the Metropolitan Water-Works.

THE ROSS REGULATOR (Fig. 1).—In the Ross valve a small and a large piston, with a pressure chamber between them, are mounted above a disk valve, all on one vertical stem. The disk valve seats by moving upward, is sealed by a leather collar, and has an area equal to that of the lower piston. The operation of the regulator is controlled by the pressure reducing valve and the relief valve, respectively, on the small pipes connecting the main inlet and outlet through the pressure chamber. The pressures at which these two valves will open and close is adjusted by hand wheels, so set that the reducing valve will close at as nearly as possible the same pressure as will cause the relief valve to open. The water pressure in the controlling or pressure chamber is intermediate to that on either side, and is sufficient to balance the low pressure water on the bottom of the disk valve when the delivery or outlet pressure has reached the desired point. When the desired outlet pressure is exceeded the disk valve is of course raised and with it the piston valve above, thus increasing the pressure in the controlling chamber, whereupon the small pressure reducing valve closes or partly closes and the relief valve opens, allowing the pistons to rise and thus to close the main valve. When the outlet pressure falls the operations just described are reversed.

Mr. Doane states that when properly adjusted the Ross regulator works closely and well for long periods, giving the best results where the inlet pressure is fairly constant, and closing entirely when the inlet pressure approaches nearly to or falls below the low or outlet pressure to which it is adjusted. This contingency would not ordinarily arise, and in some cases, such as a break in a supply main at a point above the regulator, it would be desirable to have the valve close.

THE MUELLER REGULATOR.—This device is shown by Fig. 2. The controlling feature is a large spring, compressed by the upward thrust of the outlet water upon a piston. The main valve is balanced by a second piston, below it. The valve is held open by the spring until the water pressure on the outlet side is sufficient to raise the upper piston and compress the spring, whereupon the valve is seated. To regulate the tension of the heavy springs of the larger regulators a worm gear and hand wheel are used. No comments on the serviceability of this nor the following-described regulator were made by Mr. Doane.

THE UNION REGULATOR.—In this regulator (Fig. 3) the pressure of the outlet water acting upwards on a diaphragm is balanced as desired by a weighted lever acting downward on the same diaphragm. The lever arm is connected to the valve stem and rotates an interior valve, which Mr. Doane describes as a large hollow plug cock, having several ports connecting the inlet and the outlet sides, which ports are opened or closed as the pressure on the diaphragm diminishes or increases.

THE METROPOLITAN WATER-WORKS REGULATOR.—There have been in satisfactory service in the Metropolitan district for periods ranging from 2½ to 7 years three 8-in. and one 10-in. regulating valve constructed under the supervision of Mr. Doane. A section and a half-tone view of the 10-in. valve just named are shown by Figs. 4 and 5. The valve bodies are

of the regular balanced valve type. Each of the two pistons has its bottom edge rounded off and is then conical in section for ⅜-in., and finally cylindrical for the upper ⅜-in. This gives considerable travel for small variations in the normal flow, which is small compared with the maximum capacity of the valve," while a slight additional lift provides for fire or other large flows.

As shown by Fig. 5, the stem of the balanced valve is connected with a weighted lever, attached to a combined controlling cylinder and dash pot. When the pressure of the outlet water rises above the desired point the piston in the controlling cylinder lifts the lever and thus closes the valve. The controller is so constructed as to give a variable speed, water having free access to it and the motion being comparatively rapid until the main valve approaches its seat, whereupon water is admitted slowly and the motion of both the controller and the main valve is checked. This feature, together with the conical form of a portion of the main piston valves, reduces to a minimum the danger from water ram and also prevents surging. All parts of this regulator are easy of access and those members liable to corrode and stick are made of composition.

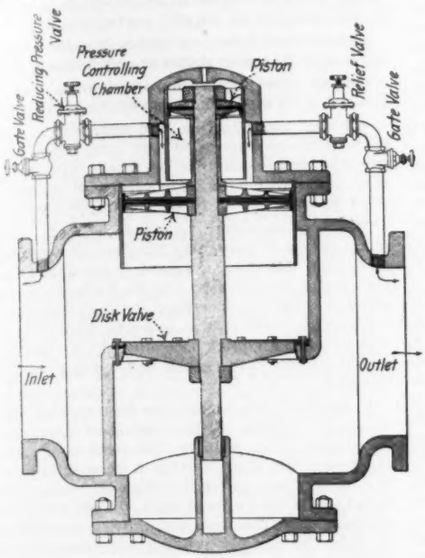


Fig. 1. Ross.

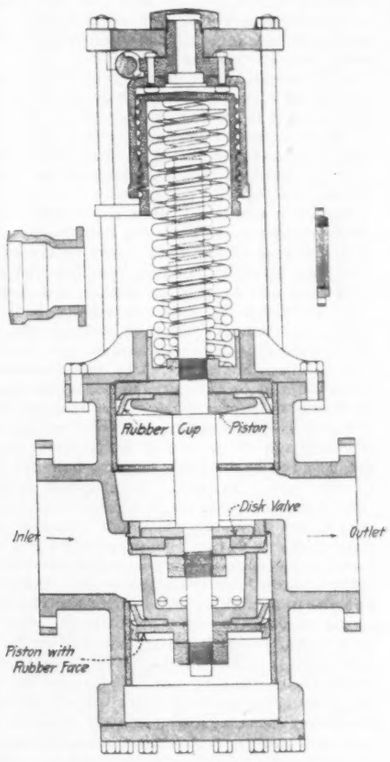


Fig. 2. 8-in. Mueller.

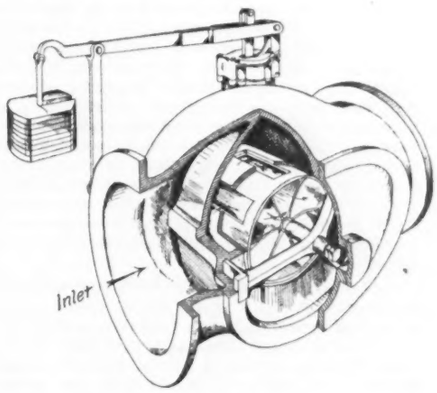


Fig. 3. 16-in. Union.

FIGS. 1 TO 3. SECTIONS THROUGH ROSS, MUELLER AND UNION PRESSURE REGULATORS.

DESIRABLE FEATURES IN PRESSURE REGULATORS.—Some of these, as given by Mr. Dohne and not already indicated, may be summarized as follows: Simple design, few parts, no delicate mechanism; control wholly from low pressure side; valve balanced as nearly as possible; sensitiveness suited to local conditions, but not so great as to keep the apparatus constantly in motion, thus resulting in excessive wear and in liability to ram and surging. Ordinarily, operation on a change of pressure of 2 to 4 lbs. will be satisfactory. In general, "a valve one or even two sizes smaller than the pipe line will be found amply large." Regulators should be set in roomy chambers, and when on pipe-lines by-passes should be provided. Sometimes a sand catcher above the regulator is advisable, but screens should not be used, as they are liable to clog and thus cut off the flow.

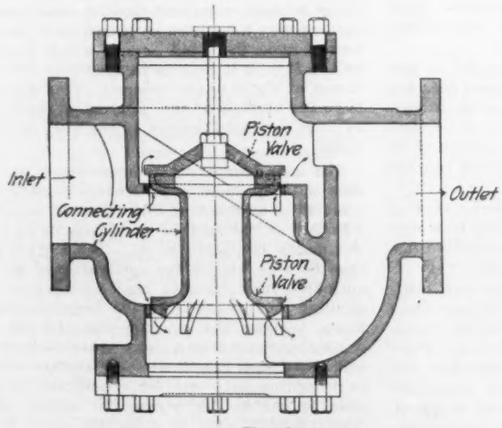


Fig. 4.

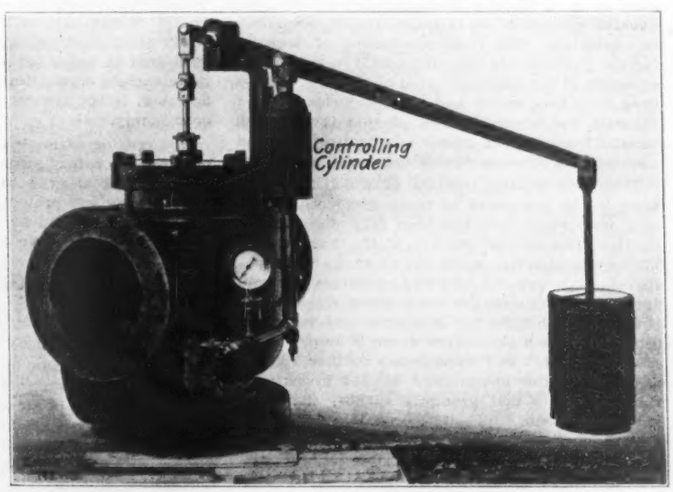


Fig. 5.

FIGS. 4 AND 5. SECTION AND VIEW OF 8-IN. METROPOLITAN PRESSURE REGULATOR.

DISCUSSION.—Mr. Edwin C. Brooks, Superintendent of the Cambridge Water-Works, said that he had had two 16-in. Ross regulators in use for eight years, controlling the flow in an 40-in. steel supply main; there are four recording pressure gages in different parts of the city, so that it has been possible to know just what the regulators have done, and the regulation has been very close. They have given no trouble whatever, except that one spring has broken. Several members added their testimony to the efficacy of small pressure regulators on service pipes where excessive or variable pressure had previously caused trouble.

THE 19TH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION.

The 19th Annual Report is of especial interest in view of the pending legislation in Congress respecting the regulation of railway rates. The commission urges that authority should be given it to determine, when a rate is found after hearing to be unlawful, what rate shall be substituted in its place. It is also urged that the new rate shall be put into force within a reasonable time unless set aside by court proceedings.

Refrigeration charges are taken up, and it is explained how a monopoly in refrigerator car service has grown up. The commission has held that the furnishing of refrigeration is a part of the transportation itself, and that the railway is obliged, under the present law, to publish and maintain its charge for icing; but the railways confidently insist that providing refrigeration is a local service, which is not and cannot be put under the supervision of any Government tribunal.

TERMINAL ROADS, ELEVATOR CHARGES AND PRIVATE CARS.—There is an important class of cases in which the owner of the property performs a part of the transportation service, and where the carrier by paying such owner an extravagant sum for the service rendered thereby prefers him to other shippers of like property.

Such preferences may take the form of an excessive division to a terminal road owned by the shipper, the payment of an excessive elevator charge to the owner of the grain, or the payment of excessive mileage upon the private car which conveys the property of the owner of the car. Investigations made by the commission leave no room for doubt that all these methods are at the present time more or less resorted to for the purpose or with the effect of preferring one shipper to another. The commission should be empowered in a case of this kind to determine whether the allowance to the property-owner is a just and reasonable compensation for the service rendered, and to fix a limit which shall not be exceeded in the payment made therefor. Such a remedy would not be altogether adequate, and any remedy is extremely difficult of application, but nothing better appears to be available.

SAFETY APPLIANCES AND ACCIDENTS.—Within the past year decided improvement has taken place in the condition of safety appliances, and at no time since the safety appliance law became effective have the results of its operation been so satisfactory as at present. An important factor in the betterment of conditions is the abrogation of local agreements at many prominent interchange points, whereby carriers, with the idea of facilitating the movement of traffic, received and delivered cars in defective condition. The rule now coming into general observance is that cars will neither be received from nor delivered to connecting roads when safety appliances do not in all respects meet the requirements of the law.

There is a noticeable tendency toward uniformity in couplers and uncoupling attachments and an increase in their strength, decreasing the number of defects.

Grab irons are receiving much better attention than formerly, and it is now the exception to find cars unequipped with this important safety device. Sill steps, ladders, and roof hand holds, when defective, introduce a great element of danger, and these appliances should be covered by the statute.

The great progress in the use of air brakes has been accompanied by marked deterioration in the condition of hand brakes, the uses of which in times of emergency are mentioned. There is still room for improvement in the maintenance of the retaining valves of air brakes.

The inspection service at present consists of 18 inspectors. With this small number of men, unavoidable delay in the investigation of complaints is inevitable. This creates a feeling of dissatisfaction and subjects the government to the charge of laxity in the administration of the law. Many lives have been saved and many injuries averted through the administration of this law, and a necessary element of proper administration is the maintenance of an adequate inspection service.

The block system, the lack of which is understood to be the cause of those accidents in the most numerous class, has been fully discussed in the last two annual reports of the commission. The commission has urged the passage of a block-signal law to prevent rear-end collisions, because, first, collisions constitute the greatest single cause of death and injuries to passengers; and, secondly, because this is a preventive which is known to be easily applied. The commission further recommends that the government should investigate train accidents and promptly furnish the facts concerning them.

HAIR CRACKS, CRAZING OR MAP CRACKS ON CONCRETE SURFACES.

By Albert Moyer.*

The appearance of hair cracks on a concrete surface is a disfigurement, the cause and remedy for which have not received the proper study that so important a subject justifies. The cause of this trouble has been investigated from time to time, but heretofore the conclusions drawn have been very incomplete.

Hair cracks, being entirely on the surface, do not indicate a weakness in the concrete; in most instances they are not greater in depth or width than that of a coarse hair. A rough-surface concrete does not display these objectionable features to as great an extent as does an even-trowelled face, on which surface they are very apparent, especially in damp or wet weather. Often these cracks do not appear for several weeks or months after the concrete has set hard.

A practical worker in concrete is not as much concerned with the cause of hair cracks and crazing as he is interested in their effect and remedy. It often requires investigation as to cause, to arrive at a correct solution of the trouble and thus apply permanent remedy, otherwise we would be simply dealing with symptoms.

Research conducted along theoretical lines seldom brings practical results, therefore the writer will endeavor to eliminate theory as far as possible. My investigation has been founded on the reverse practice; that of noting and observing very carefully the practical results both as to effect and remedy and then endeavoring to explain these conclusions by theory.

It has been known for some time that very wet concrete is more apt to craze and show these undesirable hair cracks than dry concrete. Dry concrete is objectionable from the standpoint of strength and density; and therefore its use cannot be advocated simply because hair cracks are to some extent avoided. Investigation and practical demonstration leave no doubt of the fact that in wet concrete a portion of the flour or very finest particles of the cement is carried to the surface by the action of the excess water which is being absorbed by the atmosphere. This excess water is to a great extent drawn from the interior of the stone to the exterior, carrying with it the finer particles which being deposited on the surface form a richer mortar than is contained in the body of the concrete. Under certain conditions these fine particles deposited on the surface practically form a coating of neat cement.

Neat cement or the richer mortars are found to be much more liable to crazing than mortars containing a larger proportion of sand or finely crushed stone. This is particularly true in the manufacture of cement stone by the use of sand molds in which the mixture is poured very wet. It has also been noted that, when the stone is properly seasoned by keeping the surface covered with a thick layer of very wet sand, or when the stone is immersed entirely and for some time in water, the trouble has been overcome almost entirely. These hair or map cracks would be entirely eliminated for all time if the stone were immersed in water for a sufficient period to allow the complete crystallization of the cement. This, however, is not always permitted by convenience or economy.

The crazing of neat cement is apparent in test pats for laboratory purposes, when these pats are exposed and allowed to set and harden in air. But, if they are protected in a moist closet and afterward immersed in water for a period of at least 28 days, no hair cracks or crazing will result.

A careful examination of these cracks lead to the conclusion that they are due entirely to a contraction of the surface, the same contraction not taking place in the body of the concrete.

Experiments made by Prof. Swain and Prof. Bauschinger demonstrate that neat cement when set and hardened in air contracts. This applies to all brands of high grade Portland cement. Further tests demonstrate that this contraction increases with age up to a certain period. The same authorities demonstrate that a mortar made of one part Portland cement and three parts sand, hardened in air, shows contraction but less in proportion than the neat cement. It is obvious that this bears out the practical investigations regarding concrete and cement stone which have been described above; that is, hair cracks are due to contraction of the surface and this contraction is due to the fact that the concrete has been hardened in air.

I will now describe the results obtained by investigations made by the same authorities and others showing the effects of neat cement and mortar when hardened under water. Test pats or cubes of neat cement and mortar after the final set were immersed and kept under water for a considerable period of time. The results prove that: Neat cement when hardened under water shows a slight expansion, while mortar composed of one part Portland cement and three parts sand shows an expansion but less in proportion than the neat cement. Reducing these conclusions to figures and taking the average results obtained by various authorities, figuring the expansion and contraction in percentage, I find the following results:

Neat Portland cement hardened in air at the end of 16 weeks shows a 0.15% contraction.

One to three mortar hardened in air at the end of 16 weeks shows a 0.05% contraction.

Neat Portland cement hardened under water at the end of 16 weeks shows an expansion of 0.05%.

One to three mortar hardened under water at the end of 16 weeks shows an expansion of 0.015%.

Without going further into figures it is safe to state that the expansion and contraction is less for shorter periods than 16 weeks and that the percentage will be a trifle greater if carried beyond 16 weeks or up to six months or a year.

'We can, therefore, conclude that in a rich mortar there is more neat Portland cement on the face, and, therefore, a greater percentage of contraction of the surface; also that a less rich mortar will show a proportionately less percentage of contraction, and if the concrete were kept wet and protected (which is equivalent to hardening under water), hair cracks and crazing would be avoided.

In the past this trouble has been partially overcome by brushing off the surface of the concrete or cement stone with a stiff steel brush, or by scrubbing the surface with a cement brick and wet sand, thus partially removing what might be termed a neat cement face. It has been found, however, that this does not entirely overcome the trouble, the remedy proving but temporary, the cracks appearing several months afterward. The brushing or scrubbing is merely an assistance, the real remedy lies in keeping the surface thoroughly and continuously wet as long as possible. It is unfortunate that this rule is seldom observed, and that in its non-observance good results are sometimes obtained. The worker in cement is thus influenced to disregard a matter of considerable importance in concrete construction. That good results are obtained from a disregard of these principals is largely a matter of luck. If the weather be damp for a number of days after the concrete has set, the object has been partially brought about by nature; then again, the surface may have been so placed as to escape exposure from the wind or sun which would tend to dry it, and it may have been kept wet by the excess of water in the concrete. It is desirable to have the surface of the concrete or cement stone as near the same texture as the body of the concrete.

The only permanent remedy which will eliminate entirely these objectionable features is the removal of as much of this excess of neat cement collected on the surface as is possible as soon as the molds are taken down. The surface should then be kept wet by the application of wet sand, sprinkled from time to time with water, or by hanging wet cloths over the perpendicular surfaces, keeping the exterior wet and the cloths wet by sprinkling or by any other method which will accomplish the result. The surface should be kept continuously wet for a sufficient length of time to enable the cement to attain ultimate crystallization. By so doing the effect is practically the same as that of hardening under water. It is reasonable to conclude that if so treated the surface will slightly expand but not to a greater extent than the body of the concrete which is already wet.

It is not amiss to bring this whole subject as prominently as possible before those having charge of concrete construction, endeavoring to impress upon them the necessity of keeping concrete protected and thoroughly and continuously wet for as long a period as economy will permit.

*Manager Sales Departments, Vulcanite Portland Cement Co., Flatiron Building, New York City.

STANDARD MACHINE SCREW SIZES AND THREADS, FOR SCREWS BELOW 3-8-IN. DIAMETER.

At the meeting of the American Society of Mechanical Engineers, a few weeks ago, a committee on Proportions for Machine Screws, which has been in existence for four years past, submitted a final report on this subject. This report, whose recommendations will probably be adopted by the society as standards, contains several interesting novelties. Hitherto the only threads used in ordinary screw work in this country have been the (sharp) V-thread and the Sellers thread. The committee introduces the first distinct departure in thread forms by recommending that machine-screw threads be made of a *modified* Sellers type. Further, there has hitherto been practically no adaptation of limit-gage manufacture to screwed work; the present report makes the first provision for this, by presenting tables of limits for screws and taps, and by prescribing the form and construction of limit-gages.

Due credit for the innovations embodied in the committee's report must be given to Mr. Charles C. Tyler, M. Am. Soc. M. E., who was virtually responsible for the appointment of the committee. A paper entitled "A Proposed Standard for Machine Screw Thread Sizes" which Mr. Tyler read before the Society in 1902 [Transactions of the society, Vol. XXIII., 1902, p. 603], drew attention to the unsettled condition of small machine screws, particularly those designated by screw-gage numbers (i. e. below ½-in.), as to pitch of thread. A more convenient list of sizes and pitches was advanced as a substitute for the screw-gage list in this paper; the modified Sellers thread (as subsequently adopted by the committee) was recommended in place of the true Sellers thread; and the definite specification of limits of variation was advocated. The discussion of this paper by the society showed widespread interest in the subject, and led to the appointment of a committee which should review the subject and should recommend standard sizes, pitches, and limits of variation for small machine screws. This is the committee whose report, received at the last meeting of the society, is here summarized. Its recommendations follow very closely the general lines of Mr. Tyler's original proposals; in particular the form of thread suggested in his paper is retained.

The main elements of the report are reproduced, in condensed form, in the following:

The Sellers or U. S. form of thread, having an included angle of 60° and a truncation or flat at the top and bottom of the thread equal to one-eighth of the pitch of the thread, shall be used for the basic standards.

The form of thread for machine screws shall have an included angle of 60°, a truncation or flat at the top of the thread equal to one-eighth of the pitch, and a truncation at the bottom of the thread equal to one-sixteenth of the pitch.

The form of thread for machine screw taps shall have an included angle of 60°, a truncation or flat at the top of the thread equal to one-sixteenth of the pitch, and a truncation or flat at the bottom of the thread equal to one-eighth of the pitch.

DIAMETERS AND NUMBERS OF THREADS.—The diameters of machine screws shall be expressed in decimal sub-divisions of an inch. The standard diameters for machine screws, when measured over the top of the thread, shall be the fourteen sizes given in Table I., col. 1. The standard number of threads per inch for the fourteen sizes of machine screws shall be those given in Table I., col. 2.

The pitch diameters, given in the fourth column of the table, are the diameters when measured *in the angle of the thread*, at points equidistant from the top and bottom of the threads of the basic standards.

GAGES.—Your committee recommends as the foundation of the system a set of basic standard reference thread gages, these gages to be made of unhardened steel, of 0.35% to 0.40% carbon, to represent exactly, in every detail, the U. S. form of thread, the diameter at the top of the thread, the diameter at the bottom of the thread, and the correct pitch; the included angle of 60°, and the flat at top and bottom of the thread each equal to one-eighth of the pitch. The basic standards are to be used only for comparative calibration, in the making of the reference standard plug thread gages for screws and taps.

Standard reference thread gages for screws are to be made also of unhardened steel, 0.35% to 0.40% carbon, to represent exactly, in every detail, a screw having the modified U. S. form, i. e., a flat at top of one-eighth of the pitch, and at bottom of one-sixteenth of the pitch. The gages for screws should be exact duplicates of the basic standards, in external diameter, pitch, and number of threads per inch, also in pitch diameter (measured in the angle of the thread), but to be less in diameter at the bottom of the thread corresponding to the decreased width of flat.

Standard reference thread gages for taps are also to be made of steel, 0.35% to 0.40% carbon, unhardened, to exactly represent in every detail, the size of a threaded top before being fluted, having the included angle 60°, the flat at top one-sixteenth of the pitch, with flat at bottom of the thread equal to one-eighth of the pitch, and to correctly represent the standard pitch of thread. The increased external diameters in Table I. are due to allowance for flat of one-sixteenth of the pitch and for error of lead due to hardening.

Working gages should also be made of unhardened steel, and be exact duplicates of the standard reference thread gages (for screws and taps respectively).

For inspection of screws your committee recommends the use of templet thread gages, made of steel, hardened, double end (plus and minus limits respectively), the holes being tapped to represent exactly the limits for screws.

LIMITS OF VARIATION.—A rather complex system of limit sizes is established by the committee. The final sizes are tabulated in the report and need not be reproduced here. They are based on limiting variations from standard, as represented in the following formulas.

The limit of variation for the diameters of machine screws, when measured in the angle of the thread, is,

$$\text{Limit of Variation} = 0.01 \sqrt{\text{Pitch.}}$$

The limit of variation for external diameter of machine screws, measured over the top of threads, is,

$$\text{Limit of Variation} = 0.02 \sqrt{\text{Pitch.}}$$

The standard pitch diameter is the upper limit size. The variation is to be below this size.

For taps the minimum size is to be of pitch diameter equal to the standard tap size.

$$[= \text{Std. Pitch Diameter} + 0.005 \sqrt{\text{Pitch.}}]$$

The maximum variation of pitch diameter, which is to be wholly above that size, is

$$\text{Limit of Variation} = 0.008 \sqrt{\text{Pitch.}}$$

The external diameter of tap, measured over top of threads, may vary between the following limits:

$$\text{Minimum Size} = \text{Basic Std. O. D.} + 0.005 \sqrt{\text{Pitch}} + 0.10825\ P,$$

$$\text{Maximum Size} = \text{Minimum Size O. D.} + 0.016 \sqrt{\text{Pitch.}}$$

The fact that the minimum tap size contains an allowance above standard basic pitch diameter (hence also above pitch diameter of maximum screw) is due to the need of allowing for variations in lead or pitch. The committee states that the variations in pitch may be,

For Screws, 0.004-in. per inch of length, either plus or minus the standard pitch.

For Taps, 0.0015-in. per inch of length, either plus or minus the standard pitch.

The limiting sizes are intended to be so computed that the maximum screw will just enter a tapped hole made by a minimum tap, with maximum errors of lead in both screw and tap. This refers to a length of thread corresponding to the thickness of the templet gage recommended for inspecting screws; these thicknesses vary from 0.170-in. for a screw of 0.070-in. diameter, to 0.361-in. for a screw of 0.375-in. diameter.

In addition to defining thread sizes, the committee took up the matter of proportions for slotted heads for small machine screws. The various styles of head: round (button), flat fillister, oval fillister, and flat (countersunk), are regulated as to proportions by tables given in the committee's report. The width of slot is the same for all sizes of head. The other dimensions vary. For each style of head the proportions are expressed by formula, in terms of the screw diameter. The leading dimensions are given in Table II.

TABLE I.—TABLE OF STANDARD THREADS FOR MACHINE SCREWS AND TAPS, FOR THREE-EIGHTH INCH DIAMETER AND LESS.

Basic Standard. Reference Thread Gauges, U. S. Form.				Standard Gauges for Taps. U. S. Form, except at top of Thread, which is flat ⅛ Pitch				Standard Gauges for Screws. U. S. Form, except ⅛ flat at Root	
Diam. Top of Thread.	No. Threads per Inch.	Diameter Root of Thread.	Pitch Diameter.	Diam. at Top of Thread.	Diameter at Root of Thread.	Pitch Diameter.	Excess Pitch Diameter over Basic.	Diam. Top of Thread.	Diameter at Root of Thread.
0.070	72	.05196	.06098	.07209	.05255	.06157	.00059	0.070	.05046
0.085	64	.06470	.07485	.08732	.06533	.07548	.00063	0.085	.06301
0.100	56	.07680	.08840	.10260	.07747	.08907	.00067	0.100	.07487
0.110	48	.08294	.09647	.11298	.08366	.09719	.00072	0.110	.08068
0.125	44	.09548	.11024	.12821	.09623	.11099	.00075	0.125	.09302
0.140	40	.10752	.12376	.14350	.10831	.12455	.00079	0.140	.10482
0.165	36	.12892	.14696	.16884	.12975	.14779	.00083	0.165	.12591
0.190	32	.14941	.16970	.19427	.15029	.17058	.00088	0.190	.14603
0.215	28	.16861	.19180	.21981	.16955	.19275	.00094	0.215	.16474
0.240	24	.18587	.21294	.24553	.18689	.21396	.00102	0.240	.18136
0.250	24	.19587	.22294	.25553	.19689	.22396	.00102	0.250	.19136
0.270	22	.21095	.24048	.27599	.21202	.24155	.00107	0.270	.20603
0.320	20	.25505	.28753	.32653	.25617	.28864	.00111	0.320	.24964
0.375	16	.29381	.33441	.38302	.29506	.33566	.00125	0.375	.28704

NOTE.—Diameter at Root of Thread, for Basic Standard Gauges, $= \text{Standard Diameter} - \frac{1.2990381}{\text{No. Threads per inch.}}$

Diameter at Root of Thread for Standard Gauges for Screws = Basic Root Diam. $- P(0.10825)$.

Diam. Top of Thread, Standard Gauges for Taps = Standard Diam. $+ \sqrt{P} \times 0.005 + P(0.10825)$.

TABLE II.—Dimensions of Machine Screw Heads. (In Terms of Diameter of Screw, A.)

Style of Head	Diam. of Head	Height of Head	Depth of Slot	Width of Slot
Round	1.33A	0.703A	0.40A	0.235A
Flat Fillister	1.6A	0.65A	0.325A	0.235A
Oval Fillister	1.6A	0.80A*	0.4A	0.235A
Flat (Countersunk)	2A—0.0052	$\frac{A - 0.0052}{1.739}$	$\frac{A - 0.0052}{5.217}$	0.235A

*Depth of straight part is 0.65A, same as for flat fillister.

WORK OF THE BUREAU OF YARDS AND DOCKS, DEPARTMENT OF THE NAVY, 1904-1905.*

The expenditures during the year ending June 30, 1905, from appropriations under the cognizance of the Bureau aggregated $8,710,141.14, of which the sum of $7,152,236.88 was for works of improvement for which specific appropriations were made by Congress. The remainder, $1,567,904.26 was applied to the maintenance and repair of the navy yards and stations, under the cognizance of the Bureau, for the civil establishment, contingencies, etc.

During the year 71 contracts were made by the Bureau, involving obligations amounting to $3,805,999.09, and 90 supplemental agreements, covering necessary changes in work as it progressed under contracts, were made.

DRY DOCKS.—During the fiscal year three new dry docks were practically completed, a number of new buildings were completed and put in service, extensions were made of the railroads, sewer systems, lighting systems, pavement, and other miscellaneous improvements, additional equipment was purchased, and the efficiency of the navy yards and stations generally increased. The rapid growth of the navy afloat, however, increased the demands upon the yards and stations to a greater extent than the increase in efficiency, and consequently many additional improvements and extensions are yet urgently needed.

The steel floating dry dock for the Philippines was tested by the docking of the "Colorado" and "Iowa" on June 23 and 27, 1905, respectively. The dock was found to more than fulfill the requirements of the contract and has since been formally accepted. The Bureau has recommended that it be towed to the Philippines by the Navy, and that question is now before the Department.

The granite and concrete dry dock at the navy yard, Boston, Mass., was tested by the docking of the "Maryland" on Aug. 12, 1905, the work having been delayed

*From Report of the Chief of Bureau of Yards and Docks, Navy Department, for the Fiscal Year 1905, Washington, D. C. [Mordecai T. Endicott, Chief of Bureau].

by an accident to one of the large pumps April 14 last. This dock is practically complete and will soon be ready for service.

The dry dock at Portsmouth, N. H., was tested by the docking of the "Lebanon" on Jan. 24, 1905. The test developed some deficiencies in the pumping plant, which are being made up by the contractor. These, however, do not interfere with the use of the dock, and it has been in service by the Government, with permission of the contractor, since April 4, 1904, but has not yet been formally accepted.

The other dry docks under construction are progressing favorably. The conditions at the end of the fiscal year were approximately as follows:

New York, Dock No. 4, 5% completed.
League Island, Dock No. 2, 85% completed.
Norfolk, Dock No. 3, 30% completed.
Charleston, Dock No. 1, 70% completed.
Mare Island, Dock No. 2, 25% completed.
Guantanamo, Dock No. 1, 3% completed.

Additional docking facilities are most urgently needed, and estimates are submitted for beginning docks at Boston, Pensacola, and Puget Sound, and for a steel floating dock for home waters. It should be borne in mind that it takes a considerable time to construct a dry dock of large capacity, and that by the time these docks now asked for could be completed the vessels of the Navy will have increased in number very materially, and the demand for docks will be correspondingly greater than at present.

An estimate is submitted to provide for the commencement of the construction of a steel floating dock capable of taking up an injured vessel drawing 37 ft. of water, which draft can not now be accommodated by any dry dock in the United States.

It would be located preferably at Solomons Island, Md., at the mouth of the Patuxent River. This point lies upon the west side of the Chesapeake, about 20 miles north of the mouth of the Potomac River, and about 85 miles from Cape Charles. The depth of water to the capes of the Chesapeake is ample for all naval vessels.

The steel floating dry dock destined for the Philippines is now lying in this location, where it underwent its practical tests in docking the battleship "Iowa" and the armored cruiser "Colorado." A careful examination of the situation shows it to be admirable for the mooring and operation of a floating dry dock of large size. Lying upon waters of the Chesapeake, it would afford a very valuable auxiliary to the naval establishment there, and would be a relief to the docking accommodations of the Norfolk Navy Yard, which are not ample in an emergency, not accessible for the deepest draft vessels at all times, and entirely inaccessible to large vessels injured and drawing much more than normal, which could be docked at Solomons Island.

The dry dock now there is capable of taking up an injured vessel drawing 37 ft. of water, but nothing approaching this draft could get to the Norfolk Navy Yard at any stage of the tide. In case of hostile operations on the Atlantic Coast, the Chesapeake is more than likely to be a scene of great activity, and a large floating dry dock in the vicinity, capable of being reached in a short time by any vessel in the service, injured or uninjured, would be of inestimable advantage.

An appropriation of $100,000 is asked to begin the construction, which would cost complete about $1,250,000. It is believed that this dock could be completed in less than two years from date of contract.

POWER PLANT CONSOLIDATION.—On Feb. 16, 1905, the Department directed the Bureau to undertake the consolidation of the several power plants at the navy yards, as contemplated by the act of April 27, 1904. This work was accordingly at once undertaken and is now well under way. Plans and specifications were prepared and submitted to the various interested Bureaus, and the general plans of consolidation for the principal plants have now been approved by the Department. This consolidation is in the line of modern business methods, and will undoubtedly result in a large saving in the cost of power as well as in increasing the efficiency of the plants.

ELECTRICIANS.—Owing to the consolidation of power plants under the Department's orders, it is advisable to increase the salaries of the electricians in charge to secure men properly qualified to take responsible charge of the enlarged plants. As the plants increase in size it will be necessary to ask moderate increases. As a business proposition it is folly to intrust the vital mechanism of a great navy yard to a man of doubtful competency. A single error of judgment might cost more than the salary of a competent man for a lifetime.

CIVIL ENGINEERS.—The recommendation of last year, that commutation of quarters be allowed the corps of civil engineers, is renewed. It has been granted to the corps of naval constructors by enactment of Congress, and there is good reason why the same should be accorded other shore-duty corps.

The pay of the corps of civil engineers is one of the smallest in the naval service bestowed upon commissioned officers, is inadequate for the character of service rendered, and compares unfavorably with that obtaining in civil life. One pay table having been established for the three seagoing corps—the Line, the Medical Corps, and the Pay Corps—that of distinctively shore-duty corps should be equalized with respect to each other where the attainments required and services performed are of a similarly high technical order.

It is recommended that Congress be asked to grant to the technical shore-duty corps, including the civil engineer corps, the pay and allowance established by law for naval constructors and assistant naval constructors. Such an enactment would be in the direction of equalizing the pay of officers and remove a serious discrimination which has long existed.

In the absence of such enactment and the establishing of a general pay table for all corps of the navy based upon rank, there should be such a revision of the rank in this corps as would result in compensation adequate to the character of the service exacted, and make such compensation sufficient to attract the best talent among young men in civil life.

In the examinations held in August, 1904, and January, 1905, to fill vacancies in the assistant civil engineer's grade, no candidate succeeded in making the required percentage for appointment. Another examination was held on Oct. 9, 1905, but was also without success. Three candidates appeared, but none passed, and consequently no appointments can be made.

The Bureau attributes the lack of competent candidates to the prosperous conditions existing in the private business world. Young engineers of ability are in such demand and so profitably employed by private enterprises that they are not attracted by the inducements now offered by the Government service.

The Bureau is much embarrassed by the lack of officers in the corps, but can suggest no change in the procedure to fill the vacancies. Another examination will be recommended along the same lines. No lowering of the standard for admission to the corps is advisable.

THE TECHNICAL EDUCATION OF THE TWENTIETH CENTURY.*

By John Cassan Walt, M. Am. Soc. C. E.

I am not an advocate of an extended general course in college as a condition precedent to technical training. I am no advocate of sixteen years of education before a man or woman becomes self-supporting. He or she is depending too long upon charity or is assuming a debt which he may never repay. It dwarfs the spirit of independence and self-reliance which the twentieth century needs so much. A young man who accepts his parents' or relatives' support to the age of twenty-four or twenty-six years has forfeited one of the heavenly attributes of human character, that of manly self-reliance. I would not expect great things of such a young man. If not blessed with influential relatives or friends, he must gain his experience and acquire a clientele. His married life is postponed and his ideal life shortened by a decade.

In the general courses the studies that you pursue are determined, in the larger universities, by the students' own election. The tendency is toward this plan. By it the student may take his collegiate course and at the same time pursue courses required in the professional classes. This will lead to the three years' collegiate course and is a step in the right direction, if the work of the student be directed or supervised. If he be required to elect his profession or business, and to take subjects prescribed or acknowledged to be advantageous in the vocation adopted, then it is, to my mind, most desirable. If the student be permitted to follow his own inclinations, which in four cases out of five will be those avenues of least effort, then the system is detrimental. The student may know less at graduation than at entrance. If he elect the elementary subjects in the various departments, acquire what is popularly known as general culture, and secure the requisite number of points or half courses, he can graduate with a degree, though that may mean positively nothing as an indication of what the student knows.

There is the choice of schools to consider, the large and the small, those in cities and those in country, the general and the technical. But outside of these there are also for consideration the systems that prevail. Some of the schools believe in pursuing several subjects at once, while others pursue one or two subjects only at a time. The various systems have many advocates. Each maintains that its system is "the" system. There is the choice between the elective and the prescribed courses of study, the experimental and the theoretical systems of teaching sciences.

In my opinion, it is those institutions which combine the theoretical and the practical, which limit to a moderate degree the number of courses, which prescribe courses for lower classmen and leave the election to upper classmen, that truly derive the benefits of both systems.

Technical training as offered by our industrial schools tends to develop abnormally particular lines of the intellect and greatly enlarges the scope of one's observations and power in certain directions. Such a development has been compared to the abnormal development of one of the five senses. Yet the world has need of such men. He may not be wanted frequently, but occasionally his services are required when they command great prices.

The prevailing idea is that a complete education should be acquired at school. The average graduate from college or technical school hails his degree as the final goal of his educational ambitions. Few study or expect to study after graduation, except perhaps in short crams for a civil service or professional examination. Such is not the object. The school's aim is to qualify you to study. If you do not continue with your studies you are soon going backward, and at a rate that will appall you when you come into competition with some recent graduate fresh from his studies.

A far-seeing man will, before spending very much time or money for a thing, inquire what specific uses he will make of it, and he will select the object of his purchase with a view to its qualities and its adaptations. A young man who enters college or a technical school should have some idea of what his tastes and capacities are and should be directed in the lines where his abilities would be best applied and cultivated. I am not one to advise that every man should be a perfect man; neither do I advocate that a whimsical and indolent youth should be permitted to escape essential training in mathematics and sciences by his declaration that he doesn't like them and he does like music, art and other subjects which gain flattery and applause. Yet for one's life work, it is a grave misfortune for one to school himself or herself in a business in which they have not a real liking.

Education of this century should not be confined to book learning nor to the study of mathematical and physical laws. Some time should be given to economics and sociology. Methods and means of conserving and protecting what is acquired are quite as important as are the ways, methods and means of acquiring. Close upon the footsteps of progress in its march is trade, with its competition and its protector, economy. The wasteful methods of the pioneer cannot survive the rivalry of commerce. Economy in the production and utilization of materials or power is what effects great savings, and it is the man who can effect great savings who can command a salary commensurate with his savings.

What the present century demands is the cultivation of originality and the development of the creative genius of students. Creation should be the highest aim of every student. A small thing created may be truly greater than a large thing borrowed, and the original thought or design of vastly greater import than any imitation. The present century requires the development of geniuses and especially in the technical fields. Old and trodden fields must be departed from and new, though rough, trails taken. New practices and methods must be devised and these are more likely to be discovered by departure from, than by following in the channels hewn by our predecessors.

*Extracts from Founder's Day Address, Nov. 30, 1905, at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y.

CHICAGO BUILDING ORDINANCE REGULATIONS AS TO HOLLOW CONCRETE BLOCK CONSTRUCTION.

While a number of large and important buildings have been constructed with hollow concrete blocks, the new Building Ordinance of the city of Chicago (passed March 13, 1905), limits their use to buildings of one and two stories in height. It also classes them with hollow vitrified clay blocks. The ordinance specifically refers to hollow blocks, of the "full thickness" of a wall, and seems to make no provision for the two-piece system, in which blocks of T or channel shape are put together to form a hollow wall. In reply to an inquiry, Mr. George Williams, Commissioner of Buildings, states that Section 1008 permits the use of "concrete" wherever brick or stone is called for, but that the committee which revised the ordinance did not consider "hollow block construction" good practice for buildings other than mentioned in Section 961. We give these sections in full below:

Section 1008.—Cement Concrete Walls, Solid.—Approved cement concrete of the same thickness as called for common brick or rubble stone may be substituted for either of these materials wherever either is called for in this ordinance.

Section 961.—Molded Hollow Concrete and Hollow Tile Block.—Molded hollow concrete blocks or molded hollow vitrified-clay building blocks of the full thickness of a 10-in. wall may be used wherever 8-in. walls are called for by this ordinance, and such blocks may also be used wherever 12-in. brick walls are called for in this ordinance under frame cottages and in one-and-two-story Class III and Class VI buildings.

It may be noted that 8-in. walls are the minimum, and are allowed only for one-story and two-story buildings of Class II (office buildings, hospitals, hotels and boarding or lodging houses), Class III (residences and stabling), and Class VI (tenements and apartment houses).

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The automatic sprinkler receives another notable testimonial of efficiency in the report on a recent theater fire in New York, printed elsewhere in this issue. Virtually coincident with Mr. John R. Freeman's masterly monograph on the fire-protection of theaters in our last issue, this reports adds force to the strong words there spoken upon the subject of sprinkler equipment.

To the general reader, who gives little or no thought to the problems and difficulties of fire-prevention and fire-protection, the report may not make very interesting reading. He will perhaps say to himself, after reading the recital of facts: "There is nothing remarkable in the story of this fire; anyone could have predicted the course of the occurrence, and indeed nothing else could have happened," and possibly he will mildly wonder why a page of space in Engineering News is "wasted" on such an infinitesimal as a $500 fire. But the actual condition which we must face is that not only is the value of sprinklers as a means of checking fires frequently claimed to be less than the expense and trouble which must be taken in the bargain, but their suitability to theater protection as a special field of work is acrimoniously denied in very wide circles. Probably the most active persons in such denial are theater managers of that type which considers a theater to be a private boudoir, and which cares nothing for public-safety ordinances or for prosecuting attorneys. However this may be, the existing conditions are suggested by Mr. Freeman in these words:

> The fact that we have so few actual records of what sprinklers can do in controlling a fire on the stage is due to the few instances where sprinklers have been installed in theaters or have had an opportunity to demonstrate the work of which they are capable. At least we have had no failures . . .

and in another passage:

> In Chicago, within a few months after the appalling disaster at the Iroquois Theater, the aldermen rescinded the rule calling for automatic sprinklers over the stages and rigging lofts of the theaters because the managers believed they "wouldn't do any good" and "might start a panic, should one happen to open prematurely." Every factory manager or mill engineer will admit the absurdity of such a statement. In Boston, the law still accepts the non-automatic sprinkler pipe, to be opened by hand, a device which has now been generally discarded in factory fire protection in favor of the automatic.

These quotations will also explain why the small fire at the Grand Opera House, and the report upon it, are of importance in relation to sprinklers. The occurrence adds to the very brief record of theater sprinkler performance; it demonstrates strikingly that automatic sprinklers on the stage of a theater can control a fire and keep it down to insignificant size; and it further shows that, whatever value (now unknown) for the purpose may inhere in non-automatic sprinklers, a very great additional value resides in *automatic* sprinklers. The latter fact is just as clear as the other; for, in the absence of all attendance, the fire in the Grand Opera House in the absence of *automatic* devices would have spread, would doubtless have consumed the entire theater, and would probably have menaced the safety of a good part of the block of houses in which the theater stands.

It is fair to point out that the ready impression that automatic sprinklers will *suffice* to protect a theater is erroneous. Reference to Mr. Freeman's paper will show that he places the sprinkler in second place among the needed safeguards:

> The second safeguard in order of importance is a complete equipment of automatic sprinklers. . . .

First place is given to the smoke vents over the stage. These, Mr. Freeman asserts, must be automatic opening, fitted with fusible links, and otherwise designed to meet specific and difficult conditions. In the Grand Opera House the smoke-vents are non-automatic, and the successful control of this fire might possibly be interpreted as approving such construction, an interpretation which we hold to be in error. Automatic sprinklers in theaters will often have to control more difficult conditions than here encountered. With fire originating in such a way that it can spread to all the hanging scenes before the first sprinkler opens, and occurring at a time when the curtain is raised, the sprinklers will not with certainty suffice to prevent the exit of smoke and flame through the proscenium arch, and may even permit the almost explosively rapid combustion typical of the great theater disasters. But such effects are, with certainty, prevented by a properly operating smoke vent of suitable capacity. Moreover, even when the sprinklers limit the rapidity and extent of combustion, large amounts of smoke and gases will be produced, which with curtain raised can issue into the auditorium and fill the galleries (though whether this can take place before the audience has time to escape from the building is an open question). It is doubtless this line of thought that led Mr. Freeman to accord first place in his considerations to the smoke-vent question.

If in the matters of automatic smoke vents and steel curtains there is a discrepancy between the requirements of the New York authorities and the principles laid down by Mr. Freeman, there is gratifying accord in another important fundamental: the regular inspection of fire-protection and auxiliary appliances. Both the Bureau of Buildings and the Fire Department carry on a regular inspection of theaters. The latter has recently made better provision for such inspection, as compared with that hitherto in vogue. An order issued by the head of the department under date of Nov. 4 provides for five theater districts in the city of New York (the most central one being less than two square miles in area), each in charge of an Assistant Foreman, who is relieved of all other duty, and assigns the following duties to the latter:

> Attention is called to the following extract from Section 109 of the Building Code:
>
> "The standpipe, gas pipes, electric wires, hose, footlights, and all apparatus for the extinguishing of fire, or guarding against the same, as in this section specified, shall be in charge and under control of the Fire Department, and the Commissioner of said Department is hereby directed to see that the arrangements in respect thereto are carried out and enforced. . . ."

and Theater Inspectors are charged with the duty of making proper inspections and tests of the fire extinguishing appliances, and careful examination of all apparatus, etc., for guarding against fire, in the various places of amusement in their respective districts, at least once each month, and the prompt transmission of necessary reports, when any inadequate or defective fire appliance equipment is discovered, or other dangerous condition found to exist.

This is an approach to Mr. Freeman's plea; "Let the law emphasize *fire prevention by inspection* more clearly," except that the recognition here is by departmental regulation instead of by public law, and the inspection and test are but one-fourth as frequent as Mr. Freeman demands.

The current report of Secretary of the Navy Bonaparte is a somewhat radical document in a number of its recommendations; but it has the merit of bringing to the attention of Congress things that should be attended to immediately—in the interest of the greater efficiency of the United States Navy. He first suggests a reorganization of the Department itself by reducing the number of Bureau heads from nine to three, by consolidating under one head all bureaus dealing with a like subject, but retaining the present individual organizations under this general supervision. To meet the expansion of our Navy he recommends the creation of two vice-admirals and the re-establishment of the grade of Commodore, with the corresponding promotions in the lower grades. The Secretary is inclined to believe that there is not sufficient foundation for the general complaint that the officers of our Navy are too advanced in years when they attain command rank. He admits that this feature is a hardship to the commissioned personnel and undesirable in the general interest of the service; but he says that a man is as well fitted for command at forty as he ever will be, and assuming that he retains his health, he will retain this fitness for twenty years more. As a rule, naval officers lead a far more healthful life, with much less tendency to nervous exhaustion, than men of the same age engaged in commercial enterprises or in the learned professions in civil life.

The subject of more competent engineer officers in the Navy is considered in a division by itself. The policy established under present personnel bill cannot be reversed or modified without embarrassment and an impairment of confidence in the Department, both within and without the service. But if it is clear that a mistake has been made, says the Secretary, and the consequence of this mistake is likely to be disaster, the mistake should be corrected. The theory of the present bill is that a line officer of the Navy must now be a competent machinist; just as in the old days a line officer had to be a competent sailor. And by a thoroughgoing application of the law and the consequent assignment to engineering duty of all junior line officers in turn, and their retention on such duty long enough for them to master their new profession, a thoroughly satisfactory engineering service at sea can be in time provided. But the Engineer-in-Chief of the Navy notes that the real difficulty arises in connection with the engineering service on shore. The contention is made—and properly made—that the building and repair of marine engines and the operation of these engines on board ship are separate and distinct occupations; the first requiring a more elaborate and longer training, and the devotion of a life to this one profession untrammeled by other duties. To meet this condition the Secretary suggests the prompt organization of a service of marine engineers for shore duty only, corresponding to the Corps of Civil Engineers now employed at the naval stations. This seems to be an eminently proper suggestion, for such a corps could be readily recruited from the graduates of our best technical schools; and with a comparatively brief apprenticeship under the instruction of naval officers now performing marine engineering duty at our navy yards, they would be fully competent to succeed these officers on their retirement. To a similar end it is recommended that the number of warrant machinists be increased at least one-third. And to render this service more attractive for good men, these warrant officers should be eligible for promotion to the lower grades of the proposed corps of marine engineers.

Another effort to put the "moving sidewalk" into practical operation for city passenger traffic is now being made. As most of our readers will recall, a practical demonstration of the moving sidewalk was made at the Chicago Exposition in 1894, and again at the Paris Exposition of 1900; but it has never been commercially

applied elsewhere, although its projectors, with admirable perseverance, have steadily continued their efforts to secure its adoption and have several times succeeded in enlisting powerful support for their plans.

The present proposition is to place a moving sidewalk on the new Manhattan Bridge, with loops at the ends in subway, extending in Manhattan across town to Washington St., and down town to Rector St., and in Brooklyn to Flatbush Ave. and Fulton St.

An objection that may be brought against the proposition is that for such a long distance the speed of the moving platform is too slow to give satisfactory service. However, other systems of transit would also be in operation over the bridge and it is really desirable, for the advancement of the transportation art that a large scale demonstration of the moving sidewalk idea should be made. That the system has large possibilities for the handling of city passenger traffic is admitted even by its critics; and if a single installation were made on a large scale and shown to be a mechanical and commercial success by one or two years of regular operation, it might very likely lead to a much more extended application.

The plans for the moving platform above referred to were brought forward at a recent public hearing before the Board of Estimate and Apportionment, at which the official plans for the Manhattan Bridge terminals, published in our issue of Dec. 7, were under consideration. At that hearing these plans received severe criticism from the representatives of numerous civic bodies, the principal ground of objection being that the bridge ought to have no terminals, but to be in effect a continuation of the city streets.

With that principle Engineering News is in hearty accord; and indeed this journal was among the first to publicly argue in connection with the old Brooklyn Bridge terminal problem (which has for so many years been a standing puzzle to the engineering profession), that the best solution would be to abolish the terminal entirely.

Admirable as this solution is now recognized to be, however, it can only be made possible through some unification of the street railway transportation systems of the two boroughs. The engineers who designed the new Manhattan Bridge terminals were confronted by present conditions, and they had to design their terminal to suit these conditions as well as with a view to future possible changes.

It is easy enough to say that the terminals at the Manhattan end of the East River Bridge ought to be eliminated, as the terminals on the Brooklyn side have been; but in order to do this the Brooklyn cars must continue on Manhattan Island far enough to distribute their passengers. So far as either the old Brooklyn Bridge or the new Manhattan Bridge is concerned, it is clear that there is no room on existing tracks for these Brooklyn cars, nor is it easy to see where room could be found to build additional lines for their accommodation. We do not say the latter task is impossible; but certainly no solution commanding general assent has yet been offered.

Bearing these facts in mind, it appears to us that the recent severe criticisms of the Bridge Department engineers by the representatives of several civic organizations before the Board of Estimate were entirely unjustified. This is the more deplorable because the general aims and purposes of these organizations are in general highly commendable; and because such intemperate and ill-founded criticisms of public officers acting in good faith, tend to weaken the influence of the organizations themselves and to destroy their power for good.

The very important subject of standard screw threads, which in this country has remained untouched for many years, received a notable contribution at the annual meeting of the American Society of Mechanical Engineers a few weeks ago, in the report of a special committee appointed to recommend standards for small machine screws. The committee recommended a new form of thread for such screws, a form proposed by Mr. Charles C. Tyler in a paper read before the same society three years ago. In substance it is the old standard Sellers thread, with this modification: that the thread, both on the screw and in the tapped hole, is cut slightly deeper (without, however, narrowing the top "land" of the thread), so as to give a clearance between top and bottom of engaged threads. Up to the present, only two forms of thread have been recognized as standards, in this country, for screws used as fastenings: the sharp V-thread and the Sellers flat-topped V-thread. For screws in moving engagement a thread of different form has been widely used, but screws for such service are quite distinct from machine screws and bolts used for fastening only.

There is no suggestion, in this committee's report, that consideration be given to the question of applying the Tyler modification to machine screws and bolts of the more commonly used sizes: larger than ⅝-in. diameter (these are universally measured in integral sixteenths of an inch, while the smaller screws were hitherto sized by a screw gage, but are now to be sized in thousandths of an inch). But there is no strong reason why this thread, if it be good for small screws, should not also be desirable for large screws. Perhaps there is somewhat less need for radial or tooth-top clearance in larger screws, as the relative accuracy of manufacture is greater than for the small sizes. Fundamentally, however, all the arguments for and against the Tyler-Sellers thread in the case of small screws apply also in the case of large sizes. The relative loss of net area by deepening the thread at the root is even more serious in the small sizes, since the threads here are relatively coarsest. But this factor is probably of much less moment than often thought, as the concentration and complexity of stresses near the root corners of a screw when there is no radial clearance has, no doubt, the same effect on strength as a reduction of net area with uniform distribution of stress.

We venture to express the hope, therefore, that the society may soon delegate a committee to the review of screw thread forms for machine screws and bolts of the more common sizes. The committee would work under the advantage of knowing that it could decide the question on its intrinsic merits, as the vastly troublesome questions of changing from one standard to another would not appear in this case. The modified thread will always mesh perfectly with the regular Sellers thread, provided the pitch and the nominal diameter be the same. Thus, the adoption of the modified or "relieved" thread, if the cooperation of the screw manufacturers and the makers of small tools be obtained, would inconvenience no one, would not require scrapping of tools or stock, would not require duplicate equipment, and would cause no trouble from misfits.

In our issue of Nov. 16 reference was made in this place to the acceptance of an annual guarantee from contractors having frequent occasion to bid on Government work instead of requiring a certified check to be filed with every bid. We find, however, on further investigation, that the acceptance of an annual guarantee is not yet general in the Government Departments, and that in fact the only two departments which are now accepting such guarantees are the Navy Department and the Isthmian Canal Commission, the practice originating, we believe, in the first-named organization. Besides these, the Reclamation Service has the matter under consideration, and is said to be likely to arrange for the acceptance of annual guarantees from firms supplying cement, steel and other staples, which are likely to have occasion to present numerous bids during the year.

In the War Department, where the annual guarantee system might apparently be adopted to the great convenience of both the bidders and the Government officials, the existing Army Regulations absolutely require the filing of either a special guarantee or a certified check with each bid submitted.

Of the other departments, the Interior Department, in all its bureaus except the Reclamation Service, claims to have so few cases where the same contractor presents frequent bids during the year that there would be little gained in permitting annual guarantees. The Treasury Department, on its public building work, might use the system apparently to advantage, but has made no move toward doing so.

THE DECORATIVE POSSIBILITIES OF CONCRETE.

In judging the possible decorative value of concrete as a structural material comparison is naturally made with stone. Stone is of the highest decorative value as a structural material because nature offers the designer a great variety of rock color and texture from which to choose, and this variety may be again varied by dressing and polishing, and, also, because the stone-cutter and sculptor stand ready to produce forms and patterns in unlimited variety. Is concrete similarly susceptible of wide variation in form, color and texture? In seeking answer to this question it is important first to free our minds of prejudice.

Concrete has undoubted structural value; it has strength, durability and wide adaptability, and it possesses high resistance to fire. There are very few among architects and engineers at present who dispute these statements. The decorative value of concrete has, however, received scant consideration, and by many it is even regarded as decidedly and inherently mediocre. This condition has come about partly through the neglect of architects of skill and distinction to study the material, but chiefly because of its decorative misuse by those not fitted by taste and training to handle the intricate problem of decorative design. Because, however, it is undoubtedly true that very few examples of pleasing decorative treatment in concrete can be found and that a multitude of examples of commonplace and poor decorative treatment confront us on every hand, we should not necessarily conclude that the material is wholly at fault. This very error is, however, quite certainly the reason for much of the condemnation of concrete as a material of mediocre decorative value. Concrete undoubtedly has its faults as a material for decorative construction, and some of these faults are not possessed by natural stone, but it also has its merits and neither are some of these possessed by stone.

The composition of concrete—a mixture of hydraulic cement and of fine and coarse particles of stone—and the nature of its manufacture make possible a very complete regulation of its granular texture. Within certain limits the maker can choose the size of the component particles and the relative proportions of each; he can select a fine sand or a coarse sand, or a mixture of fine and coarse sand; he can manipulate his aggregate in the same way; he can eliminate entirely either the sand or the aggregate, and he can make their ratio to each other anything he chooses; he can range the whole realm of nature in his choice of natural stone to be used for sand and aggregate; it is even possible for him to make his aggregate of different minerals, and finally he can make the face of his building unit of one composition selected for the decorative effect desired and the body of another composition selected for its structural strength.

In the same way and for the same reason the concrete mixer can regulate the color of his material. This regulation may be accomplished either by selecting colored rocks for his sand and aggregate or by tinting his mixture by an admixture of coloring matter. The range of colors at his command is wide. A contributor in another column points out the commercial practicability of producing a pure white Portland cement. This cement with crushed quartz or white marble gives a pure white concrete. By mixing a little lamp black with his cement and using a dark colored rock like basalt or trap the maker has a close approximation to a block concrete. By exactly similar means concrete can be produced that has any of the shades and tints of red, brown, yellow and green, or even of the less usual blue colors. In fact, the facility with which concrete can be colored is one of the dangers that confronts its use in decorative design.

To modify and emphasize the colors and textures offered by nature in her rocks the architect makes use of various methods of surface dressing and polishing. It is equally practicable to tool or polish concrete. In addition the concrete molder has methods of finishing his material that are not available to the stone-cutter. He can produce distinctive surface textures by molding his mixture in sand molds or molds of plaster or iron, or by washing or scrubbing or etching the molded surfaces. The possibilities in surface finish with concrete are far greater than is imagined by many engineers even, and they certainly cannot be judged by the board-welted surfaces that appear on the rough work of bridge piers and factory walls.

Passing now to the possibilities of securing in concrete the variations in form and pattern that the stone-cutter and sculptor produce in stone, it is plain that we have in this direction one of the greatest opportunities that concrete offers the decorative designer. It is frequently said in compliment of the plasticity of concrete that it can be molded to any form to which iron can be cast. This is not only true, but it is true further that the molding can be done more economically in plant and in skill, and that the resulting product is far more clear and sharp in line and form than the most skilled work of the iron founder. Pattern for pattern and form for form, the concrete molder can duplicate the work of the stone-cutter and do it at a cost which the stone-cutter cannot approximate.

Besides the ready variation in color, form and texture, which the designer in concrete commands, it is important to note the possibilities which are offered him in the way of artistic patterns produced by inlaying other materials of contrasting color and texture. The illustration of burnt clay mosaic on concrete that is given on another page is an example of the opportunities which concrete offers the decorator in the line of inlay work and mosaic. In this case an artist did the work and the result is artistic; in other cases where an artist has not done the work the result has been anything but artistic. For example, the writer calls to mind some cast window, lintel and sill blocks with an inlaid pattern of leaves and blossoms of hybrid character worked out in crushed white quartz.

Indeed, instead of concrete being intracticable to decorative treatment, one of the greatest dangers to its real development as a decorative material, is the readiness with which it lends itself to the will of every Tom, Dick and Harry who can cut out wall paper patterns and mix colors in a bucket. In concrete building construction in this country we have had very little of the skilled architect and the trained artist decorator. Instead we have had the man who divides a monolithic wall into blocks by V-shaped grooves to make it resemble ashlar, the man who molds imitation quarry faced stone, the man who inlays white quartz daisies on his window lintels, the man who faces his wall with alternate dabs of black and red mortar, and many others of like ilk. Is it much wonder that concrete has come to be regarded as possessing no value as a decorative material?

Concrete has certain real faults as a decorative material that deserve the most serious attention. It is subject to efflorescence and it is subject to surface checking and cracking. A common experience of engineers is to have otherwise presentable if not pleasing surface finishes practically ruined in appearance by hair cracks and map cracks or by efflorescence. The remedies for these ills do not seem to have been sought with the diligence that their importance deserves, for there is to-day no more vital factor in the problem of developing the decorative possibilities of concrete. It cannot be admitted that a remedy is impossible; the fact that some concretes do not effloresce or develop shrinkage cracks is proof that in some property of certain cements or in some method of compounding the ingredients, or of manipulating, depositing or curing the mixture, there lies an antidote. It is not proposed here to discuss the problem of efflorescence and shrinkage cracks, but reference may be made to the editorial discussion of efflorescence in our issue of Dec. 22, 1904, and to the paper on shrinkage cracks printed elsewhere in this issue, and in conclusion we feel compelled to suggest that some of our college laboratories could well substitute an investigation into the causes of efflorescence and shrinkage cracks and their cure for the strength tests which they repeat year after year.

Returning to our main thought, it appears to us to be beyond dispute that in its quality of plasticity we have possibilities for the wide use of concrete in decorative design.

LETTERS TO THE EDITOR.

Right Fork and Right Bank Again.

Sir: Referring to the question of "Right fork" and Left fork" in a recent issue of Engineering News, I beg to say that the terms "fork," "branch," "prong," etc., applied to the tributaries of a river, are used in the same sense as when applied to a tree or a road. That is—they are regarded as members of a system branching off from the present trunk, rather than entering the same from the outside. Therefore, the "first right fork" of a stream is the tributary entering from the right side and nearest the mouth of the same, the observer facing up stream. The "right bank" of a stream is the right side, the observer facing down stream. I think that I have never heard these terms used in any other sense than stated.

Very truly, Chas. L. Wood, C. E.

Columbus, Miss., Dec. 16, 1905.

Reinforced Concrete Piles for a Bridge Pier Foundations at Kansas City.

Sir: An article which has occasioned some interest on the part of Western engineers is that on the "Reinforced Concrete Pile Foundation for the Lattemann Building, in Brooklyn Borough," which you describe as the "largest foundation work with reinforced piles to be carried out in this country," where 480 piles were used, each about 18 ft. long, a total of 8,640 lin. ft.

There has just been completed in Kansas City the driving of 800 reinforced concrete piles, each 30 ft. long, or a total of 24,000 lin. ft. These piles are driven to support the pedestals for the Sixth St. Viaduct, now in course of construction, and are arranged with 12 piles, spaced 2 ft. 9 ins. and 3 ft. in each pedestal base of 9 ft. by 11 ft. 3 ins. The bases are 5 ft. thick and the piles extend into same 3 ft. 6 ins.

The piles are 30 ft. long, 16 ins. square at the butt and 10 ins. at the tip with a 3-in. diagonal cut-off at each corner. A circular cap about 10 ins. high to fit into the follower block was molded on the large end of the pile. A 1:3:5 concrete of ¾-in. stone was used and was mainly mixed by hand. The reinforcing was varied somewhat—at first consisting of four ¾-in. Johnson bars full length of pile placed at quarter points, and a cylinder of heavy woven wire fencing rolled and wired together at the lap. This wire was intended to occupy a position about 1½ ins. from the surface of the pile. Later the use of the wire was discontinued and the bars alone were used. The piles were cured from three weeks to a month before driving, although some were driven in two weeks. For about three days after molding the piles were showered copiously with water each evening.

The piles were driven or rather sunk by the use of a water jet consisting of a 2½-in. pipe 35 ft. long handled in the way usual for jetting timber piles. Instead of driving, the piles were churned up and down—the pile, a 10-ft. timber follower, and a hammer resting thereon, all being lifted and dropped down together while the jet on which a pressure of about 120 lbs. per sq. in. was maintained was kept playing at about the point of the pile.

The ground into which these piles were driven is a river deposit of coarse and fine sand, silt, and foreign materials, and they rest in coarse sand, gravel and clay.

This work is being done by the Foundation Company of New York, under the personal supervision of Mr. Geo. Adgate, the Western manager, and under the direction of Waddell & Hedrick, of Kansas City, the Consulting Engineers of the Sixth St. viaduct.

E. E. Howard, Resident Engineer.

New Nelson Bldg., Kansas City, Mo., Dec. 18, 1905.

(As adding another to the list of large reinforced concrete pile foundations in this country, it may be noted that, in constructing the Simmons Warehouse Building in Sioux City, Ia., some 1,900 hexagonal reinforced concrete piles, exactly similar in construction to those used in the Lattemann Building, were employed by the contractor, Mr. Frank B. Gilbreth, of New York City.—Ed.)

Railway Location to Shut Out Competition.

Sir: In your issue of Nov. 9, 1905, Mr. Walter Watson says in part:

Observations made while locating railway lines and renewing old locations lead me to believe that apparently quite a number of locating engineers do not fully appreciate the value of monopoly to their respective companies, and as a consequence do not always occupy strategic points as fully as possible.

For instance, it frequently occurs that there are two possible lines through a country, which differ only slightly, either in cost of construction or capitalized value (the monopoly feature being neglected), one of which does not fully occupy the ground (that is, it is so located that a rival road could readily be built through the same valley or pass), while the other fully occupies the ground and would make it difficult, if not practically impossible, for a rival to build a parallel road. This applies frequently to even the shortest branches and spurs.

This raises the question of competition versus monopoly, by no means a new one. It seems to the writer, however, that there may be a question involved of more importance than the comparative evils of cut-throat competition and oppressive monopoly.

The proposition is to use the charter rights given by the state, not only for the purposes intended by the state, but also to block any other railroad to whom the state may give similar rights in the same region at any time in the future. That is, to circumvent both the state and the people of the state, provided they wish to encourage other railroad construction in the same neighborhood. Perhaps there should be little objection were it proposed to conduct the obstructive tactics in such a way that a court could distinguish between such acts and the lawful use of the franchise. But the obstruction is to be done by manipulating the location; the location being of itself lawful and necessary.

Suppose, however, that the railroad declines to mix a lawful with an unlawful purpose, and builds its main line first on the natural and best location; then throws out a spur track through the gap or pass to block the other railroad, comes into court, makes a clean breast, and says that the spur track is not necessary to the use of its franchise, except to block the other railroad. In that case, would any court prevent the condemnation of the spur track by the new railroad? If such an attempt at obstruction is unlawful, where it can be dealt with separately, does not the method of obstructive location proposed, really become a subterfuge to evade the law?

Grant that the law may be considered defective, and that the engineer resorts to an artifice, in order to protect lawful interests against pirates. How about the other application of the same principle, when lawful interests are trying to enter territory controlled by a monopoly? Would it not be best for engineers to follow as closely as possible the well recognized principles of good engineering, rather than questionable methods of obstruction, which in the end may be evasions of the law, and against the best interests of the country and people at large?

As to the laws of the different states, those of Virginia and West Virginia are favorable to railroad building.

The Virginia Code (Chap. 54A., Sec. 1294D, Par. 19) provides that no railroad shall have the right to an exclusive occupancy of any pass, defile or valley; but any other railroad, whenever its line can be built without obstructing the first, can use the tracks and other property of the first railroad, as far as necessary to give them passage through the defile; the terms, conditions and compensation for such use to be prescribed by the State Corporation Commission, subject to appeal, unless agreed on between the railroads.

The West Virginia Code provides (Sec. 11, Chap. 52) that to avoid the necessity of any crossing, or of frequent crossings of a railroad, or to facilitate the crossing thereof, or the construction of a parallel work, the second road can bring a suit in equity and in a proper case the court may decree that such crossing or alteration of the first road may be made. In this case, the successful litigant has to go into a court of law to determine the amount of compensation, as in ordinary condemnation suits.

It is, of course, difficult for an engineer to pass on questions of law, and to constitute himself judge and jury. But without anticipating perfection, legally or otherwise, he might, perhaps, with due care, get far enough "to strike a fair general average."

Yours truly,

C. P. Howard, M. Am. Soc. C. E.

Charleston, W. Va., Dec. 15, 1905.

Concerning Dynamite Carrying Steamers and the Type of Canal to be Built at Panama.

Sir: On Oct. 4, 1905, an editorial appeared in the "New York Press" relating the case of the British steamer "Chatham," which, laden with explosives, caught fire while going through the Suez Canal and was sunk by her crew. Subsequently she was blown up to clear the way with the result that part of the canal bank and bottom

was damaged, all of which, however, was easily repaired. In closing, the editor very appropriately writes:

A dynamite steamer on fire must be sunk at once; there is no time to choose a convenient place remote from a lock. An explosion like that of the "Chatham" would shatter any neighboring lock, cause great damage and put the canal out of commission for a long time. The case of the "Chatham" is one not to be lightly disregarded in considering the future contingencies of canal operation at Panama.

There is, of course, no guarantee that such an accident would never happen in the neighborhood of some of the great stone locks contemplated in the high-level plans of the Panama Canal, and this is a contingency which deserves no less consideration than some of the "probabilities" and "uncertainties" advanced against the sea-level canal by its adversaries.

In a national enterprise of such moment as that of the Panama Canal, the money question is not necessarily the most important consideration. Many public works have been built at a comparatively low cost only to be found inadequate a few years later and enlarged, if such a thing was possible, at a very much increased expense and great loss of time to all concerned. Unfortunately, the direct monetary value of this loss of time is seldom taken into account, probably because it is not easily estimated, even though it is almost always immeasurably greater than the actual expense.

While, in private enterprises, engineers must strive to accomplish a certain result with the least possible expenditure of time and money, yet, they should be broad-minded enough to consider a public enterprise from a different standpoint. The claims advanced in favor of the sea-level canal are just such as are the most important from the point of view of public utility.

It seems hardly questionable that a sea-level canal at Panama would better meet the demands of the world than a lock canal, and there is, undoubtedly, a strong trend of public opinion in favor of the sea-level canal, which engineers, no more than politicians and other public men, can afford to overlook. That a sea-level canal can be built at Panama practically and economically, seems to be beyond doubt, for, although some prominent engineers are against the sea-level form, other engineers, no less prominent, are in its favor. If the energy spent by those favoring some form of a lock canal at a high level, in trying to prove that the same is preferable, had been spent in devising means for building the sea-level canal as economically and effectively as possible, perhaps we would have reached a solution of the problem. Yours very truly,

J. R. Wemlinger.

71 Broadway, New York, N. Y., Dec. 16, 1905.

(We are not at all sure that our correspondent's letter is not really an argument in favor of a lock canal at Panama. A sea-level canal there will be a deep, narrow ditch all the way across. The sinking of a large vessel at any point in such a canal, may block the entire traffic, as the Suez Canal was recently blocked by the sinking of the "Chatham." But with the lock canal a large proportion of the navigation will be in a broad and deep inland lake, and if a vessel were sunk there no obstruction whatever would result to navigation.

As for the newspaper editor's statement that an explosion like that of the wrecked and submerged "Chatham" would shatter any neighboring lock, we should say that the lock would have to be pretty close to the explosive to suffer very serious damage. The force of an explosion under water is not transmitted laterally to a very great distance; and substantial masonry, such as that in a great canal lock, is not easily blown to pieces by any means. The mathematical chances of a shipload of dynamite being sunk inside a lock are almost infinitesimally small; and if such an event should occur, the lock could doubtless be drained and the dynamite removed, the duplicate lock being used meanwhile for the canal traffic. —Ed.).

Notes and Queries.

In the profile of hump grades in the gravity freight classification yard at Alexandria, Va., published on p. 583 of our issue of Nov. 30, an error was made in Fig. 2 in the grades over the weighing scales. These were stated at 0.05 on the southbound track and 0.03% on the northbound track; but actually the grade at the scales is 0.83% in both cases.

In our issue of Dec. 14 (p. 638) in describing the blading of the new Allis-Chalmers steam turbine, we called attention to the similarity between the design and that shown on p. 571 of our issue of Nov. 30 in a cut entitled "Details of Parsons Steam Turbine Blades." We now learn that the title to this cut was an error. The turbine blading there shown is that used by the well known firm of Williams & Robinson, of Rugby, England, but it has never been used in a marine turbine, we are informed, except in an experimental torpedo boat recently built by the Yarrow firm. The American patents for this blading are owned by the Allis-Chalmers Co., which sufficiently explains the similarity of design which we noted.

A. C. writes:

Will you inform me through the columns of your paper as to the method used in arriving at the force in pounds developed by a moving body striking against a fixed body, knowing the weight of the moving body and its rate of speed.

Are not the strengths of armor plates determined by some such method?

The computation of the instantaneous pressure developed when a moving body strikes a stationary body is a somewhat complicated operation and only an approximation can be made at best. Our correspondent speaks of a fixed body; but there is no such thing as an absolutely fixed body because there is no substance which is absolutely inelastic. If there were an absolutely inelastic substance, such as the adamant which was created in the imagination of a past generation, and if one such adamantine body in motion were to strike another absolutely fixed in position, the pressure produced at their point of contact would be infinite.

Practically, when a large stationary mass is struck by a comparatively small moving mass, a great pressure is produced at the point of contact even when the speed of the moving body is very small. The limit to this pressure is set only by the elastic limit of the material of the contact surfaces. If the material has a high elastic limit, like hard tempered steel, a large part of the energy of a light blow may be expended in causing the striking body to rebound. For illustration, take a light steel hand hammer striking a steel anvil. If the same hammer strikes the same blow on an iron anvil, little rebound will occur but a slight dent will be made on the anvil surface. Or if a copper hammer strikes a steel anvil there will again be little rebound, the work done being on the face of the hammer.

As for our correspondent's question respecting armor plate; the blow of a projectile striking an armor plate is measured not by the instantaneous pressures developed against its face (which are practically indeterminate except as a matter of very rough approximation) but by the foot-pounds or foot-tons of energy in the striking projectile which are equal of course to half its mass multiplied by the square of its velocity.

A PRISMATIC LEVELING INSTRUMENT.

A new form of leveling instrument, which promises special convenience in many classes of service, has recently been introduced by the instrument-makers Otto Fennel Sohne, of Lassel, Germany. Its novelty lies in the employment of a pair of prisms in the telescope-tube for the purpose of greatly shortening the telescope for given focal length. The advantages resulting from this feature, in convenience of transport and handling, and in smaller risk of accident or derangement, will be apparent. The view Fig. 1 herewith, from a photograph of the instrument, exhibits the compactness of the instrument more strikingly.

Fig. 1. View of Fennel Prismatic Dumpy Level.

The instrument is constructed as a dumpy level, that is to say the telescope tube is permanently fixed to the vertical axis. The abolition of the wyes does not necessarily imply reduced accuracy or serviceability, as is proved by the use of the dumpy construction in the [illegible] level of the U. S. Coast & Geodetic Survey (Eng. News, July 2, 1903, p. 2). On the contrary, starting with the instrument in adjustment, the dumpy level should remain in adjustment longer and deteriorate less, than the wye level. When these features are reinforced by the added ruggedness of an extremely short telescope (about 6 ins. long), which yet gives a high magnification, an instrument of great service value is secured. It should be remembered, further, that while the wye type of level requires a long telescope for accuracy, in order that the wyes may be placed a sufficient distance apart, in the dumpy type there is no value in having a long telescope, except as this implies higher magnification.

The construction of the Fennel prismatic level is shown in the sectional views Fig. 2. The telescope tube is a rectangular box fastened to the top of the vertical cone. The objective and the eyepiece-tube are offset with respect to the longitudinal center line, to opposite sides. The two right-angle prisms, set vertically, reflect the rays four times between the two lens-systems. Focussing is accomplished by moving the eyepiece-tube in or out, by means of a screw and rack. The eyepiece adjustment, to bring the cross-hairs into focus, is provided by mounting the rear lens of the ocular in a tube which by rotating is moved slightly in or out in the main eyepiece-tube; a diagonal slot in the latter, engaged by a stud on the inner tube, produces the motion of adjustment.

This level is usually made with three leveling screws, as customary in Europe. It may, however, be made with four leveling screws to suit American practice. A clamp and tangent screw are provided. The level is set on the top of the telescope tube. The eyepiece is inverting, but a small eyepiece prism can be furnished which erects the image. The method of adjusting the instrument is the same as for any dumpy level.

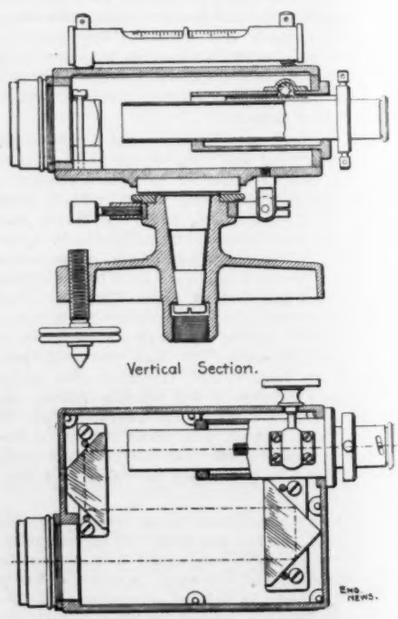


Fig. 2. Vertical and Horizontal Sections of Fennel Prismatic Level.

Arrangements are being made to introduce this instrument in the United States through Mr. E. G. Soltmann, 123 East 42d St., New York City.

THE PUBLIC LIGHTING PROBLEM is to be the subject for the 1905 essays for the William H. Baldwin prize of $100, given annually by the National Municipal League, of Philadelphia, for the best essay on a subject connected with municipal government and written by a student of an American college. The exact topic is "Franchise grants to gas and electric light companies."

A NON-FIREPROOF THEATER SAVED BY AUTOMATIC SPRINKLERS.

A fire occurred in the Grand Opera House, an old time theater in New York, N. Y., on the morning of Nov. 29, 1905. The theater is of non-fireproof construction, and the fire, which originated in some scenery on the stage, was not detected immediately; yet when fire apparatus reached the scene only a very short time was required to extinguish the fire, and the reported total damage is only $500. These results are to be credited mainly to a sprinkler system installed in the stage less than two years ago by order of the municipal authorities.

Immediately after the great fire in the Iroquois Theater, Chicago, in January, 1904, Mayor McClellan of New York City appointed a Committee on Theaters, to investigate the theaters in the city, and to recommend such changes and improvements as might be found necessary to make the several theaters conform with requirements of law and to make them fit for safe public use. This Committee consisted of Mr. Rudolph P. Miller (Chief Engineer Bureau of Buildings of the Borough of Manhattan), Dr. Walter Bensel (Assistant Sanitary Superintendent, Department of Health), and Mr. William T. Beggin (Chief of Battalion, Fire Department), representing the three departments directly concerned with the conditions to be studied. Pursuant to its findings many improvements were made in a number of the theaters in the city; what was done in the case of the Grand Opera House is suggested in the report below. Fireproofing treatment of all scenery was required, and has since that time been strictly enforced by inspection and test.

Since the time this committee made its investigation, nothing has occurred to put to test the improvements made. The Grand Opera House fire gives the first indication of this sort. While it occurred when the theater was empty, and therefore involved none of the elements of the theater panic, it contained all the other elements which make theater fires formidable. It would appear, from the circumstances, that unless this fire had been controlled in its incipiency the entire theater would have been destroyed, with great menace to the lightly built stores and dwelling houses adjoining on all sides.

A special report on the Grand Opera House fire was made to Fire Commissioner Nicholas J. Hayes by the Bureau of Violations and Auxiliary Fire Appliances of the Fire Department, in charge of Battalion Chief W. T. Beggin, who also was a member of the committee above referred to. The report recounts the circumstances of the fire in succinct manner; it is here reprinted substantially in full, as follows:

This theater is located between 23d and 24th Sts., near Eighth Ave., and while the main entrance is through a four-story office building at the corner of 23d St. and Eighth Ave., the theater proper is at the rear of this building in the space between the houses on 23d and 24th Sts. The auditorium is about 8,000 sq. ft. in area and the stage about 4,800 sq. ft. Adjoining and communicating with the stage are two small buildings on 24th St., which are used as dressing rooms, property rooms, carpenter shops and storage for scenery. All the buildings are of ordinary construction, with brick walls and wood floor beams, and while the theater is classed as non-fireproof, its present condition is excellent, viewed from the point of view of exits for the audience, fire stops and fire protection.

'As a result of the investigation of the committee above mentioned—Ed.] a number of minor improvements were made, but more important were those which provided for completely isolating the stage from the auditorium and for equipping the stage with proper fire protection appliances. The proscenium wall, for example, was made an effective fire stop by having the asbestos curtain properly hung in grooves and dropping automatically; unnecessary passageways between the stage and the auditorium were bricked up and the necessary openings cut off with standard automatic fire doors. In the same way the 24th St. buildings, which contained more or less combustible material, were cut off from the stage, in order to prevent fire or smoke in those buildings communicating to the stage. On the stage the fly galleries and the rigging loft were fireproofed with metal (the scenery was treated with fire-resisting material—Ed.) and the skylights arranged to open automatically by releasing a single rope attached at the stage level. In the matter of fire protection appliances, the stage and the 24th St. buildings were equipped with standard automatic sprinklers, supplied by a gravity tank of 14,000 gallons capacity, located on the roof.

On the completion of these changes required by the committee, the insurance rate on the theater decreased from more than $4, a figure which had prevailed for 13 years, to a trifle over $2, practically the minimum rate for this class of risk.

After the evening performance on Nov. 28, 1905, the fireman detailed to the theater made a final tour of observation at 11.30 p. m., and at this time there was no indication of fire. During the night the building is in charge of a watchman. The next morning at about 7 a. m. a citizen noticed smoke issuing from the 24th St. buildings, and notified Engine Co. 19, located on the next block, about 1,000 ft. from the theater. The company turned out and on arrival at the theater the officer in command sent out a first alarm from the street box at 23d St. and Eighth Ave., station 375. The chief of the 7th Battalion responded immediately, and in view of the class of buildings and the indications of considerable fire, sent out a second alarm, to which responded the chief of department, a deputy chief and three battalion chiefs, eight engine companies, three hook and ladder companies, a water tower and two companies of the fire patrol. When entrance was effected by way of 24th St. the buildings were heavily charged with smoke, and with considerable difficulty the battalion chief made his way through these buildings and reached the stage, where he located fire at the north side near the proscenium wall. As the companies arrived they were disposed so as to cover the stage, three lines being stretched through the auditorium and five lines through the 24th St. buildings. On the stage the smoke was so dense that the firemen could not determine the extent of the fire until the building was ventilated by the opening of the skylights. As soon as the smoke cleared sufficiently to show extent of fire, the sprinkler supply was shut off and the lines from Engine Cos. 19, 3 and 1, as well as house lines from standpipe on stage and fly gallery levels operated, completing the work of extinguishing the fire in less than five minutes, leaving only the necessary washing down and overhauling to be done.

The fire started in a pile of scenery on the stage level and burned upwards through the fly gallery floor, but did not spread beyond this nor in a lateral direction for more than about 15 ft. It was confined to the one pile of scenery, a result which is due in a large measure to the sprinklers, which undoubtedly controlled it until the fire department could get their lines to work. As a probable cause for this fire an examination of the fire area suggests the contact of scenery with steam pipes. The stage is heated by steam coils, carried on racks against the side walls, about 3 ft. from the floor; when the scenery is not in use it is piled against the side walls and in this case some of it was probably close enough to the steam pipes to be heated sufficiently for ignition to occur.

On reviewing the facts of this fire, it seems a fair conclusion that the improvements secured by the committee prevented a slight fire from developing into a very serious one. The automatic sprinklers were installed through the efforts of the committee and if these had not been in the building there is little doubt that the fire, starting in the early morning, would have attained great headway before it was discovered and the fire department summoned. As the stage building is simply one large room, everything in it is exposed to a single fire, and while it is not solidly filled with combustible material, nevertheless the contents are such as would make a very hot fire while it lasted. At present the stage is cut off with standard fire doors and an asbestos curtain properly hung, but the conditions before the committee secured these improvements were little calculated to hold a fire under headway. The cut-offs and fire stops were defective and in poor condition, and judging from previous experience with iron doors and non-automatic devices as fire stops, it was to be expected that a hot fire on the stage would have extended to the 24th St. building and to the auditorium before the fire department could possibly get enough lines in position to check it.

It is worthy of special notice that the curtain was down during the night and that it effectually prevented smoke from getting into the auditorium, not only during the early stages of the fire, but practically during its duration. When the fire department entered the auditorium, and this was at the very least half an hour after the fire started, it was comparatively clear of smoke, a result which is to be ascribed to the fact that the curtain was run in metal grooves and thus made a tight joint at the proscenium arch. This is of special value in that it indicates the practicability of keeping the auditorium free of smoke from a fire on the stage.

It has always been contended by the committee that if the asbestos curtain be promptly dropped, the skylights opened, and the automatic sprinklers in condition for service, a stage fire in New York city could be handled in a manner not only to minimize the danger of fire, but also to reduce considerably the chances of panic in the audience.

Reported damage, $500.

The facts are related in somewhat different manner by the inspector of the Bureau of Buildings. He reports that examination a few hours after the fire showed the fire to have been on the left side of the stage, near the proscenium wall, just back of the "second entrance."

The fire evidently originated behind the scene pack at that point, from what cause could not be determined. There were no electric lights in this vicinity that could have started the fire; there was no steam on, so that it could not well have originated from the steam coils.

The damage done by the fire consisted in the destruction of the scene pack where the fire started. There was some damage to the tormentor by the charring of the woodwork and the canvas, but the tormentor was not destroyed. None of the hanging stuff was damaged by fire, nor was there any other of the standing stuff damaged on the stage. Practically the entire show, however, was so badly damaged by water that performances were ordered discontinued by the management on that account. The fire set off the automatic sprinklers over practically the entire area of the stage (see a more accurate statement below—Ed.), which was largely responsible for the damage by water. The scenery had all been treated to make it fire-resisting, as required by the regulations of this Bureau, and a report on the test was filed on Sept. 5, 1905. I consider that this treatment of the scenery prevented the entire destruction of the stage and probably the building itself.

The following additional facts concerning the equipment of the Grand Opera House have material bearing on the subject.

Sprinklers.—Two tiers of sprinkler heads were installed, covering the entire area of the stage and extending under the fly-galleries on either side. One tier was at the fly-gallery level, about 25 ft. above the stage; the other at the gridiron, just below the roof, about 80 ft. above the stage. The spacing of the sprinkler heads was 10 × 10 ft., and the number of heads on the stage was 97 (the sprinkler equipment of the entire theater comprised 624 heads). The fire caused 19 sprinkler heads in the lower tier to open, and 17 heads in the upper tier. The installation conformed to the rules of the New York Board of Fire Underwriters and was approved by this board. The hand valve in the supply pipe was sealed open. It was closed by the firemen shortly after their arrival. The tank was practically emptied by this time.

Fire-Resisting Treatment.—All scenery used in all theaters of New York City is required to be fireproofed, which is done by the application of a fire-resisting wash on the back of the cloth. It is required, as a test of the sufficiency of the treatment, that

in the case of fabrics, scenery and the wood frames for the same, there must be no flame or glow after the application for fifteen seconds of the flame of an ordinary alcohol lamp or torch.

Other woodwork may be required to be protected by metal or by fireproof paint. The latter must be applied on cleaned surfaces, and is not considered satisfactory unless it so

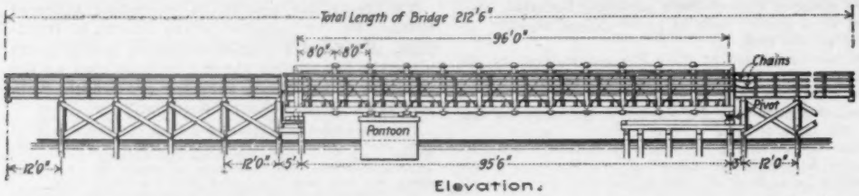
protects the wood or other material to which it is applied that the same will not flame or glow after having been subjected to the flame of a gasoline torch for two minutes.

The application of fire-resisting materials must be repeated whenever it is found that the material no longer withstands the above tests.

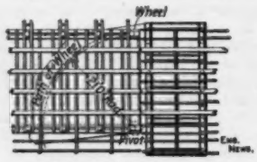
In the case of the Grand Opera House the fire-resisting condition of the scenery was tested after the fire by the regular test above described, with the following result. The scenery at the north side of the stage, where it was near the fire, and was subjected to much wetting by sprinklers and fire-streams, did not stand the test. Samples taken from scenery of the south side of the stage, however, still met the test requirements when tested three weeks after the fire. The latter samples had not been exposed to fire, as no fire spread beyond the immediate neighborhood of the point of origin, and were probably not subjected to much wetting, as the sprinklers on this side of the stage had not opened.

Smoke Vent.—The smoke vent skylight over the stage is required by the New York Building Code to have an area one-eighth that of the stage, to be self-opening when released, and to be held shut by a hempen rope so located that it can be cut by a person on the stage when it is desired to open the vent. The Grand Opera House was fitted in accordance with this law. The stage and the adjoining auxiliary buildings became filled with smoke so dense that the firemen could not cross the stage until they had cleared the smoke by opening the smoke vent.

Source of Fire.—There is some doubt on this



Elevation.



Part Plan.

FIG. 1. TEMPORARY BRIDGE WITH PONTOON DRAW SPAN; OVER THE CHICAGO RIVER.

Thomas H. Pihlfeldt, City Bridge Engineer; FitzSimons & Connell Co., Builders.

point, and the two reports above printed give different explanations. The fire insurance inspectors have also reported that the heat of steam pipes started the fire, so that this explanation appears to lead. At this theater there are Sunday evening performances distinct from the week day performances, and generally the scenery for the former is stacked up on the stage during the week. This is the material in which the fire started. The scenery on the stage at the time is said to have been quite large in amount, probably almost or fully equal to that on any stage in the city.

Municipal Control.—Of interest in connection with this fire is the means by which the city controls the fire-protection equipment of theaters. The regular supervision is in the hands of two offices of the city government: the Bureau of Buildings, which is a part of the Borough President's office in each borough of the city, and the Fire Department, an autonomous department whose head is appointed by the Mayor. When summary action is required, it is carried out by the Police Department at the request of these supervisory offices.

The division of responsibility is, broadly, on the basis that the Bureau of Buildings has jurisdiction over all means for preventing fire or minimizing its effects, while the Fire Department has jurisdiction over appliances and arrangements for extinguishing fire. As this is actually applied, the Bureau of Buildings controls fireproof construction, fireproofing of scenery, and construction and operation of curtain and smoke vent (besides such items as fire-escapes, exits, passageways, etc.). The Fire Department controls automatic sprinklers, fire pails and extinguishers, etc., and has two firemen in attendance at each theatrical performance. Both offices carry on a regular inspection of theaters to ensure compliance with their requirements. The Bureau of Buildings makes a regular monthly inspection, and in addition has occasion to enter the various theaters nearly every week to order, inspect, and test the fire-resisting treatment of new scenery. The Fire Department, through specially-delegated inspectors, inspects and tests the fire-extinguishing appliances once a month.

A TEMPORARY BRIDGE WITH PONTOON DRAW SPAN OVER THE CHICAGO RIVER.

In the renewal of city highway bridges over navigable streams it is sometimes necessary to instal temporary bridges with draw spans, and an interesting example of this class of structure is now in use near the site of the new 22d St. bridge over the Chicago River. This is a pile trestle with a swing span having one end supported by a pivot on the fixed work, and the other end supported by a fixed bearing when closed and by a scow or pontoon when swinging. It carries a double-track electric railway and is located a little distance up stream from the site of the permanent bridge. The width of the river at this point is 200 ft. between dock lines and the length of the temporary bridge is 212 ft., as is shown in Fig. 1.

The draw span is about 100 ft. long, and gives a clear waterway of 72 ft. when opened. This span, which is illustrated in detail in Fig. 2, has two combination trusses 96 ft. long, divided into 12 panels of 8 ft. each. There are four floor beams to each panel, and these rest upon the bottom chord, some of them being extended on one side to carry a sidewalk. Upon the floor beams are four stringers for the 7-in. girder rails of the tracks and five lines of intermediate joists. Side posts and cross arms (not shown on the drawing) carry the trolley wires.

The swing span is pivoted at one corner by a cast steel pivot with a hemispherical surface of 6 ins. radius, bolted to a bolster composed of a pair of 12x12 in. timbers under the ends of the bottom chords. This pivot rests in a cast-steel socket bolted to heavy timbers on the end of the fixed trestle work. Under the opposite end of the bolster is an 18½ in. cast-steel wheel, 9 ins. wide on the face; this rides on a ½-in. track plate 24 ins. wide, laid to a radius of 21 ft. The free end of the bridge has a bolster which takes a bearing on the trestle when closed, but when swinging this end is supported on a pontoon, Fig. 3, placed under the third panel from the end, and each truss rests on two screw jacks seated on heavy timber framing in the pontoon. These jacks are fitted with worm wheels and sprocket chains, and are all operated simultaneously by a small electric motor when changes in the river level make it necessary to raise or lower the floating roadway to coincide with the approaches. The draw is operated by an electric motor on the pontoon, geared to a double drum to which are attached two chains whose outer ends are anchored at opposite sides of the river. The draw can be opened or closed in about one minute. The arrangement of the machinery for swinging and leveling this span is shown in Fig. 4. The weight of the draw is about 100 tons, of which 65 tons are carried by the pontoon.

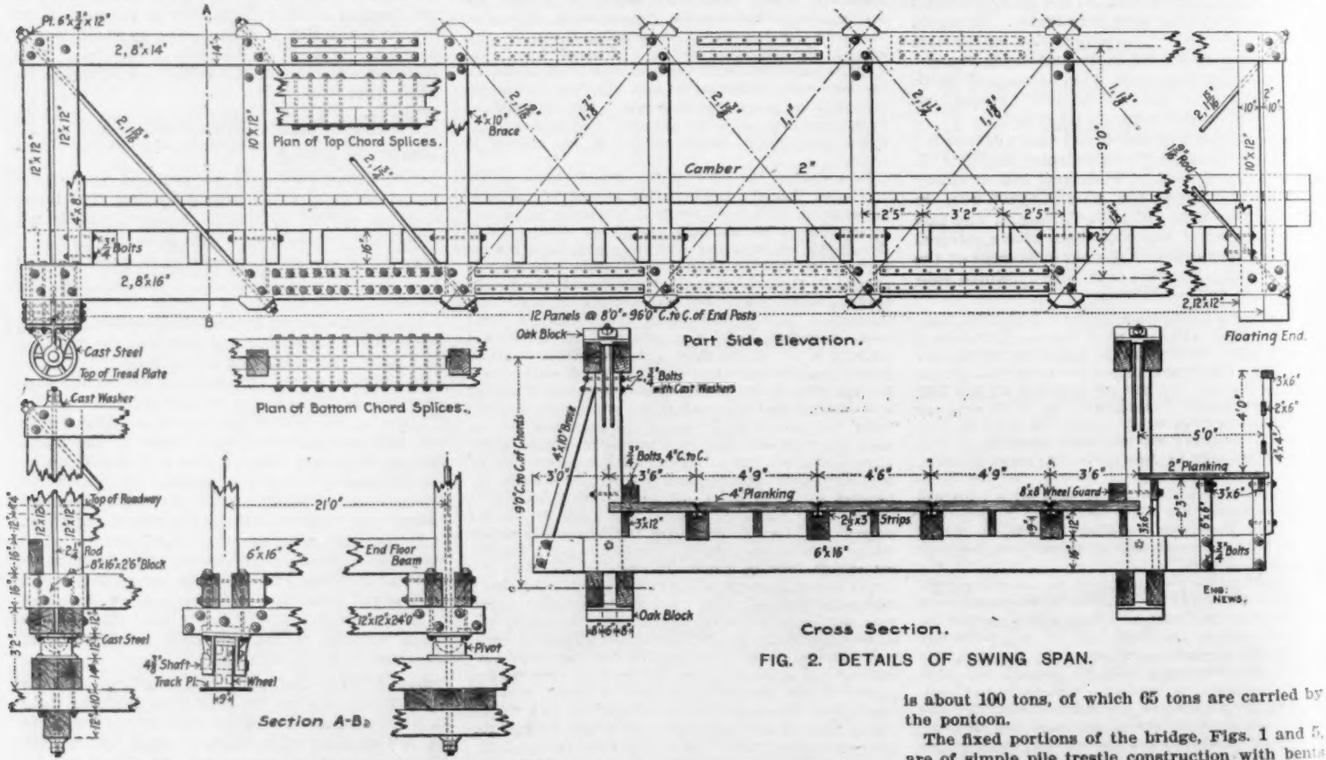


FIG. 2. DETAILS OF SWING SPAN.

The fixed portions of the bridge, Figs. 1 and 5, are of simple pile trestle construction with bents 12 ft. apart. Each bent has eight piles, and five of these rows of piles are connected by longitudinal X bracing. Pile clusters protect the bridge from being struck by passing vessels.

This bridge was designed in the city's Bureau of Engineering, under the direction of Mr. Thomas C. Pihlfeldt, City Bridge Engineer; and was built by the FitzSimons & Connell Co., of Chicago. The

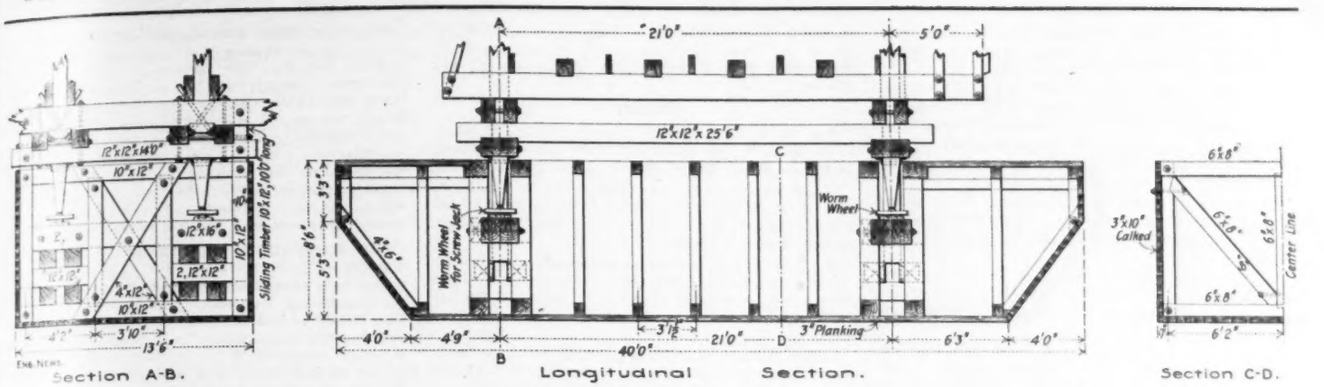


FIG. 3. DETAILS OF PONTOON.

cost complete was about $10,000, of which the draw span (with pontoon and machinery) represented $5,600. The dead load is taken at 2,000 lbs. per lin. ft. on the swing span, and the live load at 2,000 lbs. per lin. ft. of bridge, with local wheel loads of 5,000 lbs. per wheel. The bridge being low, and its floor solid it cannot be affected by any ordinary wind pressures. The trusses, floor beams and pontoon are of yellow pine; the piles are of Norway pine; the caps, pivot platform and roadway flooring are of white oak. For the timbers in the trusses, a strength of 800 to 1,000 lbs. per sq. in. of net section was assumed. The permanent bridge will be of the Scherzer rolling-lift bascule type, and the contractors are the Great Lakes Dock & Dredging Co. for the substructure, and Jackson & Corbett for the superstructure.

The first temporary drawbridge of the type above described on the Chicago River was used during the reconstruction of the North Western Ave. bridge; another is in use at Archer Ave., and still another will be used at North Ave. A somewhat similar type of bridge designed by Roemheld & Gallery for use during their construction of the State St. bridge, was described and illustrated in our issue of Aug. 21, 1902. This bridge (which was never built, traffic being diverted) was to be for foot passengers only, and to have two trusses 117 ft. long and 11 ft. apart. The pivoted end was to have a bolster with a pivot pin at the middle and a conical wheel or roller at each end, instead of a pivot and wheel at opposite ends of the bolster as in the 22d St. bridge. It was to be operated in a manner similar to that of the latter bridge. Many of the numerous renewals of old swing bridges with new bascule bridges at Chicago have been effected without installing temporary structures, the traffic being diverted to adjacent bridges.

THE PHILADELPHIA RAPID TRANSIT railway along Market St., from the Schuylkill River to 15th St., was opened for public traffic on Dec. 18 after a formal inspection and opening luncheon on Dec. 16. A full description of the proposed new rapid transit lines planned by the Philadelphia Rapid Transit Co. was published in our issue of Dec. 29, 1904. The road is to be partly underground and partly elevated, the main underground lines being under Market St. and Broad St. and intersecting in a common loop around the City Hall. Beginning at 62d St. on the west the Market St. line is elevated to and across the Schuylkill River, it then dips underground and continues below the surface until near the foot of Market St. on the Delaware River where it rises again onto elevated structure. The portion opened for traffic is the short section from the Schuylkill River to 15th St., which crosses Market St. between the front of the Broad St. Station of the Pennsylvania R. R. and the City Hall. The next piece of construction will be the loop around the City Hall. Mr. W. S. Twining is Chief Engineer and Mr. Charles E. Mills is Principal Assistant Engineer of the Philadelphia Rapid Transit Co., and the E. E. Smith Contracting Co. built the section just opened for traffic.

AN INDEPENDENT WATER SUPPLY SYSTEM for the Chicago stockyards and the neighborhood is proposed by the associated companies interested in the stockyards and packing industries. It is stated that a franchise could not be obtained for supplying the stockyards alone, as that would not be a public utility, but it is proposed to furnish a supply for a certain fixed territory. This district would include many of the largest consumers of city water, and it is considered doubtful whether the council would grant a franchise for a plant operating in direct competition with the city's system and at lower rates. If a sufficient supply could be obtained from wells no franchise would be required for a supply for the stockyards, but in view of the amount of water required (said to be about 33,000,000 gallons per day) the supply must be taken from the lake, and pipes cannot be laid through the streets without a franchise. Plans have been prepared under the direction of Mr. H. C. Gardner, Superintendent of Construction, Swift & Co.

THE PROTECTION OF WATER POWER RESOURCES from "export," or foreign exploitation, is planned by the Swiss Federal Government. It is proposed by the Council, in a communication to the Assembly, to establish by law the following principles: The utilization in foreign countries of electrical energy produced wholly or in part by Swiss water power requires to be approved by the Federal government, which will grant 20-year franchises in case there is no home demand for the energy in question and the foreign utilization of this energy does not conflict with home interests. Every franchise of this kind may be abrogated at any time by the Federal government, the holder being then entitled to compensation.

A CHICAGO-ST. LOUIS DEEP WATERWAY has long been projected, and surveys have been made by the U. S. Engineer Corps upon which an estimate of $30,100,000 has been based. This is for a depth of 14 ft. of water on the miter sills of the locks, but it has been found that 66% of Chicago's lake trade is carried in steamers of over 14 ft. draft. The board of engineers appointed to investigate this project has reported that the traffic would probably be carried by steel barges with tugs, but the use of barges has ended on the Mississippi River and is declining on the lakes. The total distance from Lake Michigan to the Merchants Bridge at St. Louis is 365 miles, and the mouth of the Illinois River is 38 miles above the bridge. From the proposed ship lock at Lockport, the end of the Chicago drainage canal, the Des Plaines and Illinois rivers would be utilized, with nine locks and five movable dams between Lockport and Utica. The present dams would be removed, and a 200-ft. channel would be dredged from Utica to Grafton. The locks would be of concrete construction, 600 × 80 ft. In view of the fact that a still deeper channel, possibly for vessels of 20-ft. draft, is talked of, the board estimates that to increase the depth from 14 ft. to 20 ft. would add about $1,376,000 to the cost, but calls attention to the fact that this project would draw so large an amount of water from the lake that same remedial works would be necessary.

The project of a lake and gulf waterway is behind the present project, but, we add, lest anyone be misled, the construction and maintenance of a 20-ft. (or a 14-ft.) channel from St. Louis to the Gulf would be stupendous and costly work, out of all proportion to its value as a traffic carrying route. However, a bill has been introduced in Congress to appropriate $31,000,000 for the Chicago-St. Louis 14-ft. waterway.

ROAD SPRINKLING TO LAY DUST RAISED by motor cars is receiving attention in Geneva. The dust nuisance and the means taken to reduce it is discussed as follows in a note from U. S. Consul Keene, Geneva, Switzerland, in "Daily Consular Reports" for Dec. 12, 1905:

Motor car dust is a perennial pest which renders living in suburban and country houses situated on important roads most unhealthy and uncomfortable. I am informed that it has been found impossible of late to either lease or sell certain villas in the French Riviera, and that the paradise of the motorist has become the inferno of the inhabitant. Public opinion in Switzerland, desiring to put a stop to a state of affairs so objectionable, founded in 1904 the Swiss league against road dust, and already good results are shown. After several trials on different roads and streets in Geneva, both the cantonal and municipal authorities applied antidust preparations on 36,000 sq. meters of road (110,610 sq. ft.). The spring was most unfavorable for antidust applications, and the material and preparations were not obtained by the authorities until the middle of August last.

The preparations mostly used have been hot coal tar and, in a less quantity, hot "Lambercier asphaltine" (manufactured in Geneva), which is found efficient but expensive, and gas tar with water. Westrumite and apulvite have not given the good results which were expected. In general, however, the results have been satisfactory, and the treatment will be continued next year. Private proprietors have also applied antidust preparations on the busy roads passing their country houses.

PERSONALS.

Mr. J. A. Shepard has been appointed Superintendent of the Maryland Division of the Western Maryland R. R.

Mr. Isaac A. Hopper has resigned his position as Superintendent of Buildings, Borough of Manhattan, New York City.

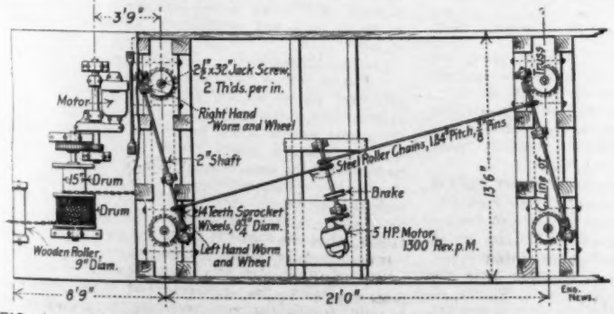


FIG. 4. PLAN OF MACHINERY FOR SWINGING AND LEVELING THE DRAW SPAN.

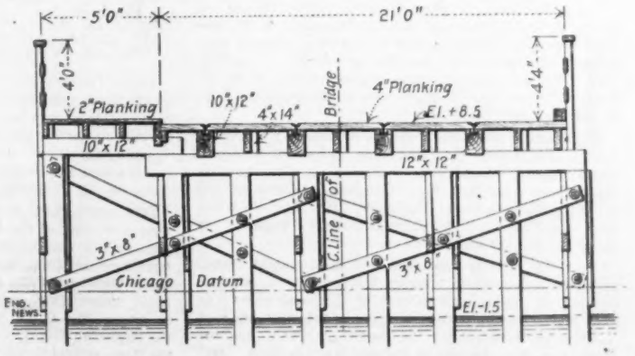


FIG. 5. FIXED PORTION OF TEMPORARY BRIDGE.

Mr. G. L. Humphrey of Toluca, Ill., has been reappointed Chief Engineer of the Toluca, Marquette & Northern R. R., under the recent receivership.

Mr. Dennis Madden has been appointed General Superintendent of the MacArthur Brothers Co., Contractors, with headquarters at 810 Fisher Building, Chicago, Ill.

Mr. Martin Rapp, formerly Bridge Engineer on the Oregon R. R. & Navigation Co., is now with the Western Pacific Ry. Co., located at Chilcoot, Plumas Co., Cal.

Mr. Charles P. Riford, on the Surveying Corps of the Boston & Maine R. R., has resigned, and will have charge of the construction of a section of the South & Western Ry.

Mr. Isham Randolph, M. Am. Soc. C. E., has been reappointed Chief Engineer of the Chicago Drainage Canal by the new Board of Trustees of the Chicago Sanitary District.

Mr. Nettleton Neff has been promoted from Engineer of Maintenance of Way of the Chicago Division of the Pennsylvania Lines to be Division Superintendent at Richmond, Ind.

Mr. Kenneth Allen, M. Am. Soc. C. E., Superintendent of the Atlantic City Water-Works, has been appointed Consulting Engineer for the new storm water Drainage Commission, of Baltimore.

Mr. R. N. Hudson, heretofore Chief Engineer of the Louisville, Henderson & St. Louis Ry., has been appointed General Manager of the Louisville & Atlantic R. R., with headquarters at Versailles, Ky.

Mr. William Van Gilder, formerly connected with the Public Works Department of Philadelphia, Pa., will become Superintendent of the Atlantic City Water Department on Jan. 1, in place of Mr. Kenneth Allen, resigned.

Mr. James A. McCrea, formerly operating Superintendent of the Pennsylvania Lines West of Pittsburg, will become General Superintendent of the Long Island R. R. on Jan. 1. Mr. McCrea is a graduate of Yale University.

Mr. A. B. Newell has resigned as Vice-President and General Manager of the White Pass & Yukon Route, and the office of Vice-President is abolished. Mr. A. L. Berdoe, heretofore Comptroller, has been appointed General Manager.

Mr. Charles E. Pugh, second Vice-President of the Pennsylvania R. R., has been elected President of the Baltimore, Chesapeake & Atlantic Ry. and the Maryland, Delaware & Virginia Ry., to succeed the late Sutherland M. Prevost.

Mr. A. I. Culver, second Vice-President of the Delaware & Hudson R. R., has been elected Vice-President and a director of the United Traction Co., of Albany, N. Y., recently acquired by Delaware & Hudson R. R. interests, to succeed Mr. Francis N. Mann, Jr., resigned.

Mr. A. H. Horton, Hydrographer, will take charge of the hydrographic work of the Chicago section of U. S. Geological Survey, succeeding Mr. F. W. Hanna, who will be placed in charge of the Technical Section of the Reclamation Service at Washington, D. C.

Mr. O. F. Alexander Sandberg, Assoc. M. Inst. C. E., has entered into partnership with his father and brother to carry on the business of Consulting and Inspecting Engineers, established by Mr. C. P. Sandberg, M. Inst. C. E., with offices at Palace Chambers, Westminster, London, England.

Mr. R. K. Compton has been advanced to the position of Assistant Engineer in charge of paving repairs, Baltimore, O., succeeding Mr. J. A. Paige, who becomes Assistant Engineer in charge of paving improvements and sewers. Mr. O. W. Connet has been appointed Assistant Sewerage Engineer.

Mr. John W. Maxcy, Consulting Engineer for the Houston & Texas Central R. R., has been employed by the Swift & Armour Co. to make complete tests and investigations of the packing-house sewage and waste products with a view to installing a complete system of purification at the company's North Fort Worth packing plants.

Mr. J. B. Carothers, Superintendent of the Illinois Division of the Baltimore & Ohio Southwestern R. R., has been appointed Superintendent of the Ohio Division with office at Chillicothe, O. He will succeed Mr. E. R. Scoville, who has been appointed Superintendent of the Illinois Division with headquarters at Washington, Ind., in place of Mr. Carothers.

Mr. Albert M. Brosius, formerly engineer in charge of sewers, Baltimore, Md., and now connected with the Rapid Transit Commission in New York City, has recently been appointed first Assistant Engineer of the Sewerage Commission of Baltimore. Mr. Ezra B. Whitman, Jun. Am. Soc. C. E. is appointed Engineer in charge of the Disposal Plant.

Mr. Hugh J. McGowan, President and General Manager of the Indianapolis Traction & Terminal Co., will relinquish the active management of the local street car lines, owing to the added work connected with his new position as President of the Syndicate which has recently formed a merger of Indiana traction lines. Mr. Robert I. Todd, of Providence, R. I., now General Manager of the Rhode Island Co., which controls nearly all the traction lines of Rhode Island, will succeed Mr. McGowan.

Obituary.

Mrs. W. E. Mott, wife of Professor William E. Mott, of the Massachusetts Institute of Technology and formerly of Ithaca, N. Y., died in Brookline, Mass., on Dec. 11.

Charles Craske died at his home in Woodbridge, N. J., Dec. 17, at the age of 83. He was the inventor of stereotyping, which he first used on the "Tribune," at the suggestion of Horace Greeley.

W. J. Spicer, formerly General Manager and Director of the Grand Trunk Lines west of Detroit and St. Clair Rivers, died recently at his home in Detroit at the age of 73 years. Mr. Spicer retired from active business in 1894.

Luther Fillmore, formerly Superintendent of the South Pacific Coast (narrow gage) R. R. between Oakland and Vera Cruz, Cal., died last week at the age of 79 years. Mr. Fillmore was a pioneer in railroading, building the Syracuse and Binghamton R. R. in 1848.

Charles B. Peck, Manager of the Texas Car Service Association and President of the National Association of Car Service Managers, died at Houston, Tex., on Dec. 10. Mr. Peck has held the following important positions: General Manager of the Chicago & Grand Trunk Ry.; Vice-President and General Manager of the Atlantic & Danville R. R., and General Manager of the San Antonio & Aransas Pass Ry.

Matthew P. Wood, M. Am. Soc. M. E., died in New York City, on Dec. 23. Mr. Wood was 70 years of age, and for the past 20 years., owing to ill health, has done little practical work, confining himself principally to literary work. Prominent among his books were: "Rustless Coatings;" and "Corrosion and Electrolysis of Iron and Steel." During the Civil War, he was Superintendent of Motive Power of the United States Railways, serving under General Haupt, and was also confidential agent for Secretary Stanton.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN ECONOMIC ASSOCIATION.
Dec. 27 to 29. Annual meeting at Baltimore, Md. Secy., F. A. Fetter, Ithaca, N. Y.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 29 to Jan. 4. Annual meeting at New Orleans, La. Secy., L. O. Howard, Washington, D. C. Secy. of Section D (Mechanical Science and Engineering), Prof. W. T. Magruder, Columbus, O.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 4, 1906. Annual meeting at Pittsburg, Pa. Secy., F. V. McMullin, 410 Penn Ave., Pittsburg, Pa.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9, 10, 1906. Annual convention at Lansing, Mich. Secy., F. Hodgman, Climax, Mich.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 10 to 13, 1906. Annual convention at Milwaukee, Wis. Secy., C. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 10. Annual meeting at Boston, Mass. Secy., Willard Kent, Narragansett Pier R. I.

IOWA ENGINEERING SOCIETY.
Jan. 10-12. Annual meeting at Des Moines, Ia. Secy., B. J. Lambert, 24 North Clinton St., Iowa City, Ia.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17 and 18. Annual meeting at the Society House, 220 West 57th St., New York City. Secretary, C. W. Hunt, address as above.

NORTHWESTERN CEMENT PRODUCTS' ASSOCIATION.
Jan. 17, 18, 19. Annual convention at Minneapolis, Minn. Secy., F. H. Chapin, 10 N. Third St., Minneapolis, Minn.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 17, 18, 19. Annual meeting at Rockford, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

INDIANA ENGINEERING SOCIETY.
Jan. 18, 19, 20. Annual meeting at Indianapolis, Ind. Secy., C. C. Brown, Commercial Club Building, Indianapolis, Ind.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21. Annual meeting at South Bethlehem, Pa. Secy., R. W. Raymond, 99 John St., New York, N. Y.

THE PROPOSED NATIONAL ASSOCIATION OF PLUMBING INSPECTORS.—A meeting for the organization of this society has been called for Jan. 29, 30, 31, to be held in the convention hall of the New Willard Hotel, Washington, D. C. Further information regarding this organization can be secured through Mr. Henry B. Davis, Inspector of Plumbing, Washington, D. C.

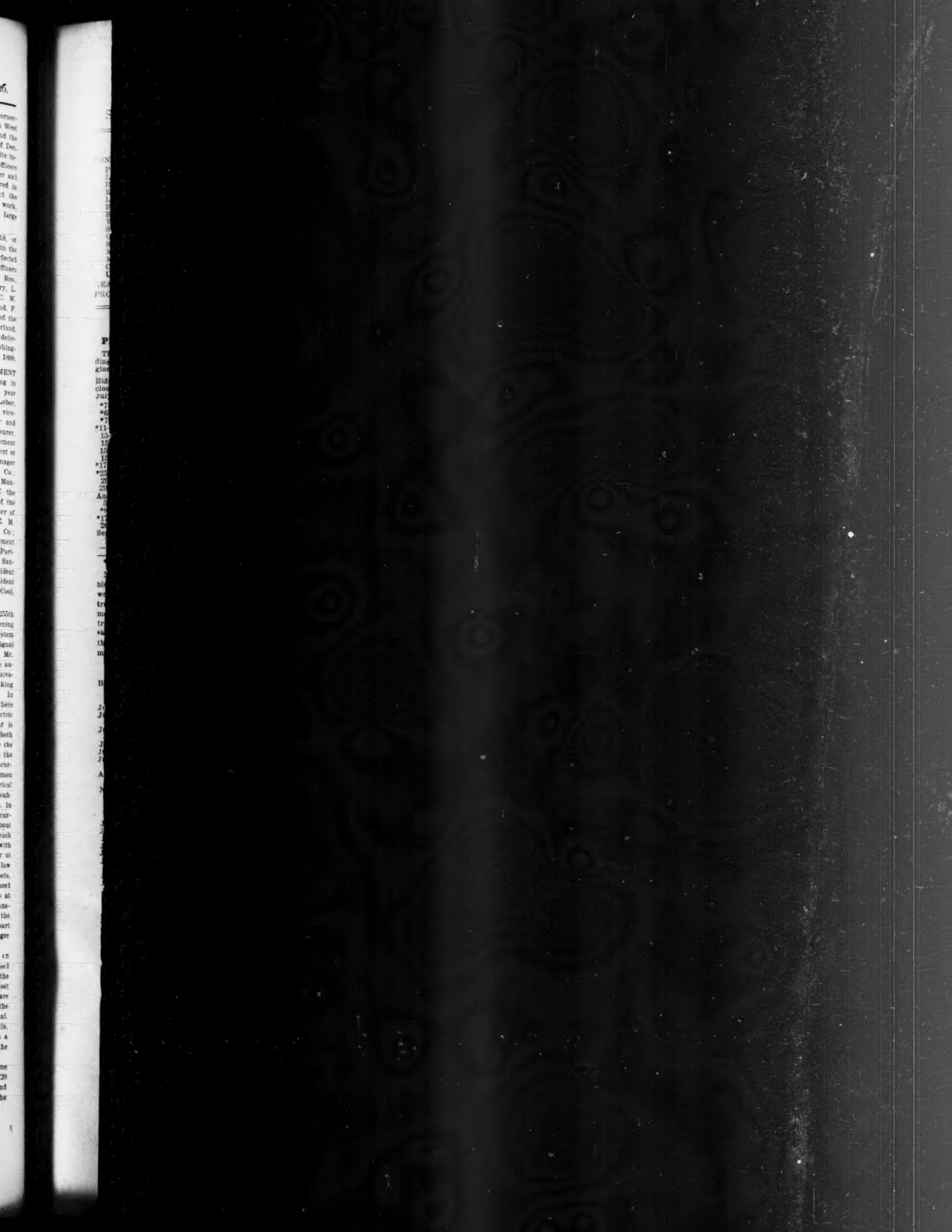
THE NATIONAL ASSOCIATION OF CEMENT USERS.—At a meeting of the Executive Board at New York City last week it was decided to change the place of the annual meeting from Milwaukee to Columbus, O., owing to the burning of the Exhibition Building at Milwaukee. Later information, contained in a telegram from the Secretary, Mr. C. C. Brown, to Mr. Merrill Watson, of the Executive Board, announces that the place of meeting has been retransferred to Milwaukee.

THE NEW YORK ENGINEERS' CLU[B] ... the corner-stone of the new building of the Engineer[s'] ... b, on West 40th St., New York City, opposite Bryan[t] ... k and the new Public Library, was laid on the af[ter]noon of Dec. 23 by Mrs. Andrew Carnegie. The ceremo[ny] ... was quite informal, but the club was well represented ... its officers and committees, including President W. H[.] ... etcher and past-President John C. Kafer. The weat[her] ... cleared in the afternoon, thus enabling the party ... inspect the building, now up to the ninth story in t[he] ... teel work, and to the third in marble and brick ca[sing]. A large number of records were deposited in the st[one].

THE WASHINGTON SOCIETY OF EN[GINEERS, of] Washington, D. C., met on the evening of ... 19 in the lecture room of the Hubbard Memorial Hall ... perfected the organization, temporarily made on Nov[ember]. Officers were elected as follows: President, Admir[al] W. Rea; vice-President, Commissioner John Biddle; ... retary, L. B. Bliss; Treasurer, B. E. McComb; Dir[ectors], C. W. Hayes, Bernard Green, D. S. Carl, W. A. M[cFar]land, F. H. Newell and O. H. Tittman. At the con[clu]sion of the election and routine business, Mr. W. A. McFarland, Superintendent of the Washington Water-Works, delivered a lecture, describing the water-works of Washington and the building of the Brightwood Reservoir in 1860.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.—At the recent annual meeting in New York City last week officers for the ensuing year were chosen, as follows: President, John B. Lober, President of the Vulcanite Portland Cement Co.; vice-President, Charles F. Wade, Secretary, Treasurer and Manager of the Omega Portland Cement Co.; Treasurer, Ernest Ackerman, President of the Lawrence Cement Co.; Executive Committee, Robert W. Lesley, President of the American Cement Co.; Edward M. Hagar, Manager of the Cement Department of the Illinois Steel Co.; Thomas J. Brady, President of the Coplay Cement Manufacturing Co.; Deuane Millen, vice-President of the Thomas Millen Co.; A. F. Gerstell, vice-President of the Alpha Portland Cement Co., and the recent purchaser of the plant of the National Portland Cement Co.; E. M. Young, Treasurer of the Lehigh Portland Cement Co.; W. R. Warren, President of the Virginia Portland Cement Co.; Wm. H. Harding, President of the Bonneville Portland Cement Co.; S. B. Newberry, Manager of the Sandusky Portland Cement Co.; T. Henry Dumary, President of the Helderberg Cement Co.; Conrad Miller, President of the Dexter Portland Cement Co., and D. McCool, President of the Newaygo Portland Cement Co.

NEW YORK ELECTRICAL SOCIETY.—The 255th meeting was held at the American Institute on the evening of Dec. 20. A lecture was given on "The Signal System of the New York Subway" by Mr. J. M. Waldron, Signal Engineer of the Interborough Rapid Transit Co. Mr. Waldron first explained in detail the operation of the automatic block signal. The length of each block is equivalent to the braking distance of the heaviest train, taking grades into consideration of course, plus about 50%. In the use of electric automatic signals on steam roads where the rails are not used for the ground return of an electric current for propulsion, a low tension direct-current is used for operating the relays of the signals, while both rails, insulated from the ground, are used to complete the circuit. On the subway system the rail farthest from the third-rail is the insulated one, carrying the signaling current alone, while the inside main rail acts as a common return for both circuits. An entirely separate electrical system is used for signaling, a generating station and sub stations supplying an alternating current at 60 cycles. In case of emergency, however, the regular propelling current at 25 cycles can be used. The current taken at about 10 volts from the secondary of a transformer at each semaphore, passes through the rail circuit in series with a grid resistance of one ohm., and actuates the relay of that signal. The relay circuit itself is operated on a low voltage direct-current, supplied by storage-battery sets, and controls the air-valves of the semaphore. Compressed air is supplied to the air cylinders of the semaphores at 70 lbs. by electrically-driven air compressors, and transmitted to the semaphores by piping along the roof of the subway. The design is such that the failure of any part to do its work will result in the setting of the danger signal.

The interlocking system is very similar to that used on steam roads, all switches being controlled by compressed air. The air valves are electrically controlled by the mechanically operated switches, which automatically set the proper signals at the same time. Safety brakes are used at dangerous places, which automatically stop the train, should the motorman fail to heed the danger signal. The brake-setting appliances are set between the rails, with an arm or trip which raises high enough to open a valve in the compressed air line of the train, and set the brakes, when the signal is in the danger position.

If one stands for an hour in the subway at a busy time of day he will see pass him about 120 trains of about 720 cars, carrying in the neighborhood of 80,000 people, and he will realize the vast responsibility placed in the hands of the Signal Department.